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SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 83 (WHOLE VOLUME)

THE SKELETAL REMAINS OF EARLY MAN

BY
ALEŠ HRDLIČKA

(PUBLICATION 3033)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
JULY 24, 1930

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

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SMITHSONIAN MISCELLANEOUS COLLECTIONS VOL. 83 (Whole Vol.)

Errata.

In the legend to Plate 8, figure 2, add the following: A, Gorilla; B, Pithecanthropus; C, Man.

In the legend to Plate 52, the words "Krapina jaw 'D'", should read "Krapina jaw 'J'".

4812

PREFACE

In 1914 the writer published a small treatise on "The Most Ancient Skeletal Remains of Man."[1] The object of the publication was to furnish reliable data, including as far as possible original observations and measurements, on the older and more valuable skeletal remains of man. The scope of the presentation was limited to the remains of human forms that differed substantially from those of the later prehistoric time and those of the present. The demand was such that the edition was soon distributed, and in 1916 the Smithsonian Institution reprinted the treatise in nearly the original form. This second edition also was soon exhausted.

Since 1916 a number of important new discoveries have been made; moreover, the writer, in the course of several additional trips to Europe, has examined personally, and in some cases repeatedly, the originals of both the older and the more recent discoveries. Also, notwithstanding the fact that many valuable contributions on the subject have appeared in print within the last decade, there is still to date no publication which deals with the ancient skeletal remains of man in any manner approaching completeness. In view of all this, and because of the many requests received for such a publication, it was felt that the preparation of a new and larger work should be undertaken; and the present volume is the result.

The principal aim of this book is to furnish accurate and, as far as possible, complete information on the earlier skeletal remains of man. If this object can be achieved, or even closely approached, then the publication should be one of permanent reference value, and further light on the problems involved, including further discoveries, may be dealt with in addenda.

---

[1] Ann. Rep. Smithsonian Inst. for 1913, pp. 491-552, 41 pls., 12 figs., 1914.

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THE SKELETAL REMAINS OF EARLY MAN

By ALEŠ HRDLIČKA

(With 93 Plates)

Introduction

The chief object of anthropology is a full knowledge of man—a knowledge of what man is from every point of view; why, when, and how he came to be; how he is progressing; and what the promise of the future is for him. Only with such knowledge can anthropology be of the greatest service to mankind. To understand man of the present and to aid in guiding his future it is first necessary to know his past; and this past goes back far beyond the time of written records. But a record there is, preserved in the great book of Nature. As environment impressed itself upon man, so also man impressed himself upon his environment. Wherever man was, he left traces of his activities and of himself, and many of the more material of these traces remain today in the deposits of the old sites and caves where man had dwelt.

These records of earlier men are of several classes. From the very oldest times there are artifacts of stone, the bones and teeth of the animals on which man lived, and, rarely, the skeletal remains of man himself. From early time also there appear shaped tusks and bones. Later there is the development of primitive art in bone or ivory, on stone, in clay, and on the walls of the caves; and eventually there appear the polishing of stone and primitive pottery. Doubtless large quantities of the more perishable articles of wood, skins, etc., together with many of the less resistant bones, have disappeared.

For almost a century an ever more careful and intense search for these old remains of man has proceeded. Men are seeking or watching for such remains in all parts of the world. And where remains are found, students often devote years of most painstaking labor in bringing to light what the deposits contain. Collectively a vast amount of work has thus already been accomplished; though it may be only a small percentage of what remains. The material results of this work already fill or enrich many museums, and the written records and studies would constitute a large library.

From all this work and study a number of major facts have become established. The first relates to time. It is of peculiar interest that probably all the remains that can safely be attributed to man belong to the Quaternary period or Ice Age. There are remains, especially those in southeast England, that have been assigned to an even older time—the late Tertiary; but uncertainties still exist concerning both the nature and the dating of these objects, and even though these uncertainties should be cleared up, there would still be the legitimate question as to whether the beings of that very remote time were fully human.

The second major fact concerns the geographic dispersion of these ancient human remains. Leaving out of consideration north Africa and southwestern Asia, which as yet present many uncertainties, the remains show an area of greatest intensity in western Europe, extending gradually as time advances over larger portions of the Old World.

The third major generalization relates to the nature of the remains. Whether these are artifacts or the skeletal parts of man himself, the earliest are seen to be scarce and primitive, the later ones showing a gradual and highly interesting progression in quantity, quality, and breadth of dispersion, until they merge into the protohistoric and then the historic. But the advance in culture, and perhaps even in the physical differentiation of man, appears to have been realized in successive stages rather than in a uniform progression. The main cultural stages of prehistoric man are now fairly well known in substance, though further studies indicate that matters are probably more complex than they have appeared and that in the not far distant future it may be necessary to revise our present views. There have evidently been irregularities and transitional stages, as well as topographical and chronological complications.

Nevertheless the present classification of the cultural remains of the early man of Europe is useful in subdividing man's past and thereby facilitating our comprehension of it. On the other hand, however, it tends to establish in the minds of the students sharp limits where no such limits have existed in reality; also it leads them to consider the subdivisions as general chronological criteria, whereas no such use is justified.

As to the paleontological remains associated with those of early man, they have been exceedingly useful in the dating of the human cultural and skeletal material. But here also matters are far from simple. The Quaternary fauna is seen to have been rich, the appearance, duration, and extinction of individual species very uneven, and their geographical distribution irregular. As a result of all this the problem of the chronological identification of human remains by means of the remains of the extinct animal forms has become, in many cases, a matter for highly expert knowledge and most careful consideration. One of the most common and serious errors in this connection is to regard the skeletal remains of man in the same light as his cultural objects. The animal remains have frequently a decisive voice in the dating of a deposit. They are of similar value in dating the cultural remains of man, except those that may have been buried with a body. But their value becomes very uncertain when they are called upon to date the bones of man himself, for the reason that, since later Neanderthal times at least, man has interred his dead, burying the bodies from two to four feet, or even deeper, in the ground. In this manner human bones in many cases may have been brought artificially into contact with older deposits and into association with older remains of animals. This important factor, simple as it is, is commonly forgotten by both the paleontologist and the prehistorian.

So far as the skeletal remains of early man are concerned, science is now rich beyond the most sanguine expectations of the earlier students of ancient man, and the material is of very great scientific value. But there are still many important gaps; there are many secondary and yet important problems to be solved; and there are numerous uncertainties about some of the individual remains; all of which intensifies greatly the need of more discoveries of skeletal material, particularly from the earlier periods of man's existence.

The present volume will be devoted essentially to the object of giving the original accounts and the most reliable information in general, on the skeletal remains of early man. These are without question the most important objects for the student of man's differentiation.

In every case to be dealt with, the remains have been seen personally and repeatedly by the author. Original measurements were taken by modern and well-tested instruments, and the site of their discovery was in each case visited and examined. A number of these precious remains, as well as the sites from which they came, were reexamined by the author as late as the autumn of 1927.

The accounts to be given are intended to be fairly impersonal. There will be no theory to defend, no side to be taken in any controversy, though there may be suggestions where justified by the general acquaintance with the field and perhaps by the better perspective of one who is not involved in any individual finds or opinions.

In connection with his visits and studies the author has become greatly indebted to a large number of eminent friends, to whom a grateful acknowledgment is hereby tendered. They include especially Sir Arthur Keith, Sir A. Smith Woodward, and the gentlemen of the Department of Geology and Palaeontology, British Museum of Natural History, London; Professors Arthur Thomson and J. Dudley Buxton, of Oxford; Professor R. R. Marett, of Cambridge, England; M. Sinel, of the Museum of the Island of Jersey; Professors A. Rutot, Charles Fraipont and Maxime Lohest, with the sons of the latter, and those in charge of the Musée du Cinquantinnaire, in Brussels, Belgium; Professor Marcellin Boule and Dr. Henri Martin, Paris, with Professors Arcelin and Mayet, of Lyon, France; the authorities of the Museums at Périgueux, at Toulouse, at Monte Carlo, and at Barma Grande; those of the National and Anthropological Museums at Madrid; Professors Schwalbe, Lehner, Schoetensack, G. Steinman and J. Sobotta, Preparator H. Lindig (Weimar), and the authorities of the Museums in Heidelberg, Bonn, Tübingen, Stuttgart, Weimar, Jena, and Berlin, in Germany; Professors J. Matiegka, Karel Maška, and Karel Absolon, in Prague, Telč, and Brno, Czechoslovakia; Professor K. Gorjanovič-Kramberger, in Zagreb; Professor Joseph Szombathy, in Vienna; and many others who cannot be mentioned here by name.

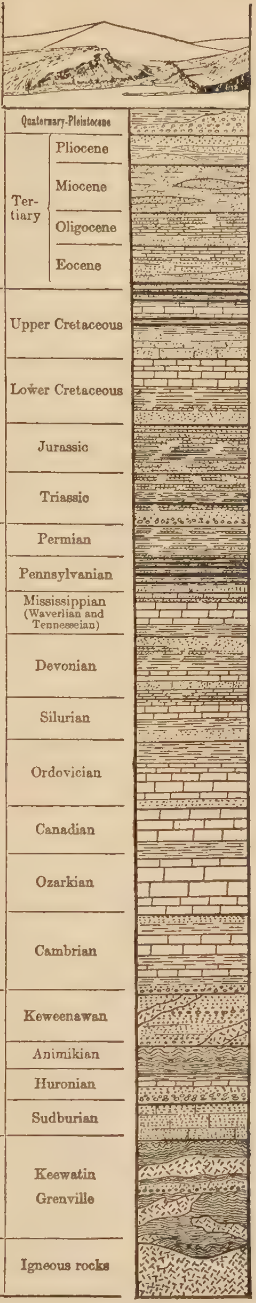
The Glacial Period

The Ice Age, or Pleistocene period of the Quaternary, was according to all evidence the period most intimately associated with the early history of man, possibly even witnessing his origin and determining his development. It is the geological subdivision of time immediately preceding the present, from which it is not sharply separated. The present may be viewed in fact as still a part of the era of deglaciation, for the ice has merely receded to the farther north and south and higher up the mountains; vast parts of the earth are still perpetually frozen or covered by glaciers. The only justifications for separating the present as a period of its own lie in the seeming relative stabilization of conditions, and in the general convenience of such a separation; but there is no line of demarcation between the two, just as doubtless there was none between the Glacial Age and that which preceded it.

To facilitate proper orientation it may be useful to show here the conventional geologic subdivision of the earth's history, though it is both very imperfect and largely artificial. The accompanying chart has been prepared by Dr. R. S. Bassler, Head Curator of the Department of Geology, U. S. National Museum, who has kindly permitted use of it.

DIAGRAMMATIC SECTION OF EARTH'S CRUST

(R. S. Bassler)



ERAS OF GEOLOGIC TIME WITH CHARACTERISTIC LIFE			CHARACTERISTIC ROCKS WITH MAXIMUM THICKNESS
PSYCHOZOIC ERA (Recent) Age of man			Alluvial deposits in rivers, etc.
CENOZOIC ERA (Modern life) Age of mammals and modern plants	Quaternary-Pleistocene		Shale, sand, and gravel
	Tertiary	Pliocene	5,000 feet clay, shale, gravel, and sandstone
		Miocene	14,000 feet shales, sandstones, and limestone
		Oligocene	6,000 feet shales, sandstone, and limestone
		Eocene	8,000 feet limestone, sandstone, and coal
MESOZOIC ERA (Medieval life) Age of reptiles	Upper Cretaceous		20,000 feet sandstone, shale, limestone, and coal beds
	Lower Cretaceous		20,000 feet limestone, shale, and sandstone
	Jurassic		10,000 feet sandstone and shale
	Triassic		15,000 feet sandstone, shale, and coal beds
PALEOZOIC ERA (Ancient life) Age of higher invertebrate animals	Permian		7,000 feet sandstone and shale
	Pennsylvanian		10,000 feet sandstone, shale, and coal beds
	Mississippian (Waverlian and Tennesseian)		4,500 feet shale and limestone
	Devonian		12,000 feet limestone, sandstone, and shale
	Silurian		6,000 feet sandstone, shale, and limestone
	Ordovician		6,000 feet sandstone, limestone, and shale
	Canadian		4,000 feet limestone and shale
	Ozarkian		6,500 feet massive limestone
	Cambrian		18,000 feet quartzite, sandstone, shale, and limestone
PROTEROZOIC ERA (Primitive life) Age of primitive plants (algæ) and invertebrate animals	Keweenawan		30,000 feet conglomerate and sandstone with lava flows
	Animikian		14,000 feet banded slates and cherts with iron ore
	Huronian		10,000 feet glacial conglomerates, quartzite, and limestone
	Sudburian		20,000 feet of white quartzite
ARCHEOZOIC ERA (Primal life) Age of unicellular life	Keewatin Grenville		100,000 feet sedimentary schist and gneiss with lava flows; slates, conglomerates, and limestone
PRIMITIVE CRUST	Igneous rocks		Granite and other igneous rocks

FIG. 1.

The length of time represented by such life on the earth as has left distinguishable traces, or from the Archeozoic era to the present, is enormous, comprising perhaps more than one hundred million years, though all estimates of geological time in years are notoriously uncertain. The greater part of this time, however, has only a secondary importance to man, the period of direct concern to him beginning only during the Tertiary period of the Cenozoic era. During the early part of this, in the Eocene or "dawn" period, there appear in America and elsewhere the earliest known members of the order of primates, the parent-order of Man. In the Miocene there are already numerous monkeys and later even some anthropoid apes. The Pliocene is the age of the higher apes and from among these, during the latter part of this period, there begin, in all probability, further differentiations that lead to forms which could only be classified as human precursors. Then finally comes the Ice Age, and from the earlier parts of this, if not even before, there commence to be found indications of beings still higher in the scale, beings that have begun to shape tools of stone and other materials; and these beings, though still very primitive in every way, can no more be conceived as precursors—they are evidently representatives of the earliest men. Such, in brief, is the prevalent view of the appearance of man on the earth. From that point on, the evidence relating to him grows steadily in mass. It shows his slowly progressive cultural and physical advance with no general interruption until he connects with man of protohistory and then history.

The peculiarly important relation of the Ice Age to man's existence and differentiation makes it highly desirable that we have the fullest possible knowledge of this period. For such knowledge the student of man must look to geology and paleontology, and these, regrettably, are not yet in a position to furnish all that is needed, owing to the great complexities of the subject.

There was a time in the earlier part of this century when, due especially to the discerning work of Penck and Brückner,[1] a good general understanding of the Ice Age seemed to have been reached. The era was represented as having consisted of four glacial invasions, called respectively, after the Alpine localities where best represented, the Günz, Mindel, Riss, and Würm glaciations; and these were believed to have been separated by three distinct interglacial periods, of which the second was the longest, and followed by the postglacial time which merged with the present. This seemed to agree fairly well with the North American conditions, where five main ice extensions have been established, namely, the Nebraskan, Kansan, Illinoian, Iowan, and Wisconsin.

---

[1] Penck, A., and Brückner, E., Die Alpen im Eiszeitalter, 3 vols., Leipzig, 1901-1909; with numerous smaller, both earlier and later, contributions by these authors.

But it gradually became apparent that matters were more complex and irregular. The studies of Brooks, Dépéret, Boule, Mayet, Rutot, Steinman, Wiegers, Soergel, Schmidt, Bayer, De Geer, the Russians, and many others in Europe, with those of Leveret, Coleman, Osborn and Reed, Antevs, and many others, in America, have shed a great deal more light on glacial facts and problems, only to show, however, that the subject is not capable of any simple and universally applicable solution. The Ice Age is now seen to have been a vast complex of phenomena and changes which obeyed no simple rule and which varied geographically and even chronologically, as they vary to this day in the areas subject to glaciation.

Paleontology and human prehistory find it particularly difficult to conform to a system of a quadruple extensive European glaciation with three major warm interglacial periods many thousands of years in duration. Had such alternations been general and severe, involving much change in climate, there ought to be, it would seem, perceptible corresponding changes in the general fauna and in the habits of man. But neither paleontological nor human mappings show such definite multiple marked oscillations. This has led observers, such as Boule, Bayer, and others, including the writer, either to doubt the existence over the man-inhabited areas of the Quaternary of the four pronounced periods of cold with three warm interglacials, or to doubt their intensity.

In connection with my Huxley lecture in November, 1927,[1] I have gone with some thoroughness into these questions and constructed several approximate charts which are reproduced in figures 2, 3, and 4. They show the main conceptions of the Ice Age in western Europe, which was the principal territory occupied by early man, and also the actual difficulties of reconciling the paleontological and human evidence with the classic claims as to the subdivisions of the Ice Age. Before these charts are introduced, however, it will be useful to outline the general cultural classification of human prehistory.

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[1] Journ. Roy. Anthrop. Inst., vol. 57, pp. 249 *et seq.*, 1927. Reprinted Smithsonian Ann. Rep. for 1928, pp. 493-621, 1929.

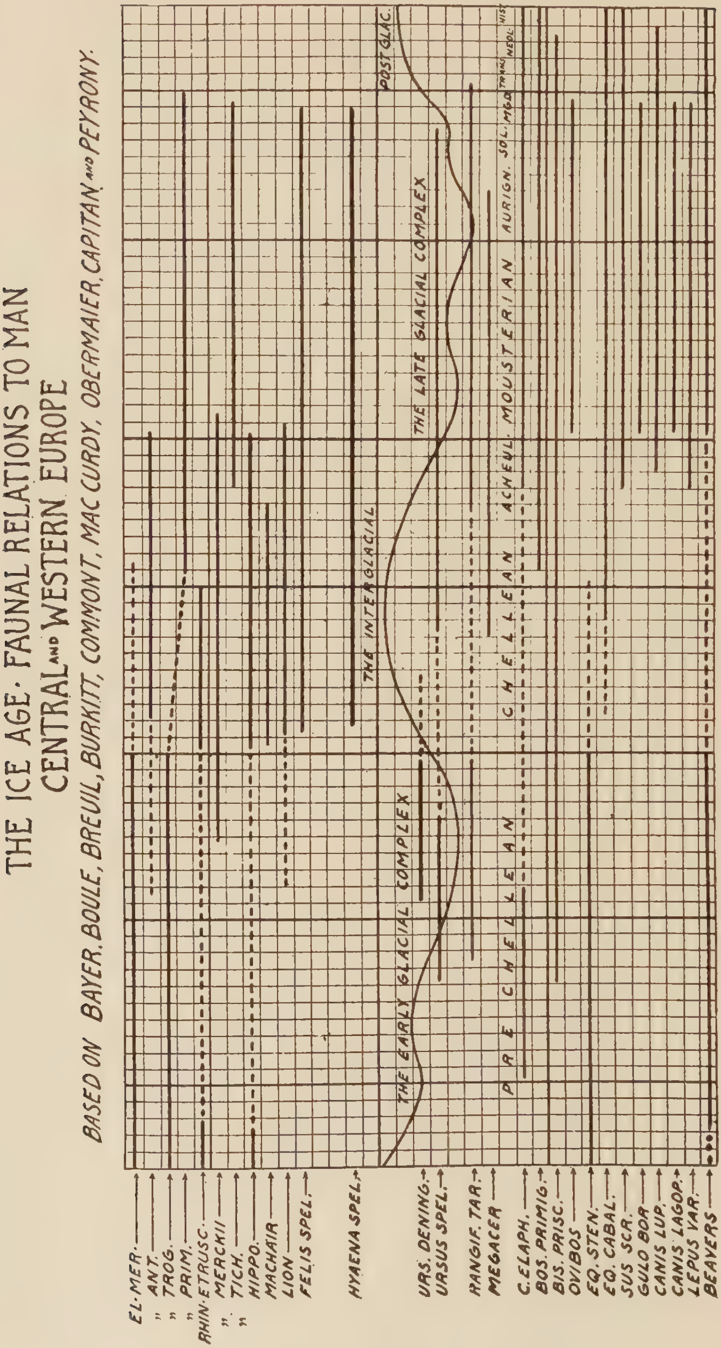
THE ICE AGE · FAUNAL RELATIONS TO MAN
CENTRAL AND WESTERN EUROPE
BASED ON BAYER, BOULE, BREUIL, BURKITT, COMMONT, MAC CURDY, OBERMAIER, CAPITAN AND PEYRONY.
EL·MER.
" ANT.
" TROG.
" PRIM.
RHIN. ETRUSC.
" MERCKII
" TICH.
HIPPO.
MACHAIR
LION
FELIS SPEL.
HYAENA SPEL.
URS. DENING.
URSUS SPEL.
RANGIF. TAR.
MEGACER
C. ELAPH.
BOS. PRIMIG.
BIS. PRISC.
OVIBOS
EQ. STEN.
EQ. CABAL.
SUS SCR.
GULO BOR
CANIS LUP.
CANIS LAGOP.
LEPUS VAR.
BEAVERS
THE EARLY GLACIAL COMPLEX
THE INTERGLACIAL
THE LATE GLACIAL COMPLEX
POST GLAC.
PRE CHELLEAN
CHELLEAN
ACHEUL.
MOUSTERIAN
AURIGN.
SOL.
MGD.
TRANS.
NEOL.
HIST.

FIG. 2.

·THE ICE AGE AND MAN·

·APPROXIMATIONS ACCORDING TO DIFFERENT RECENT INVESTIGATORS·

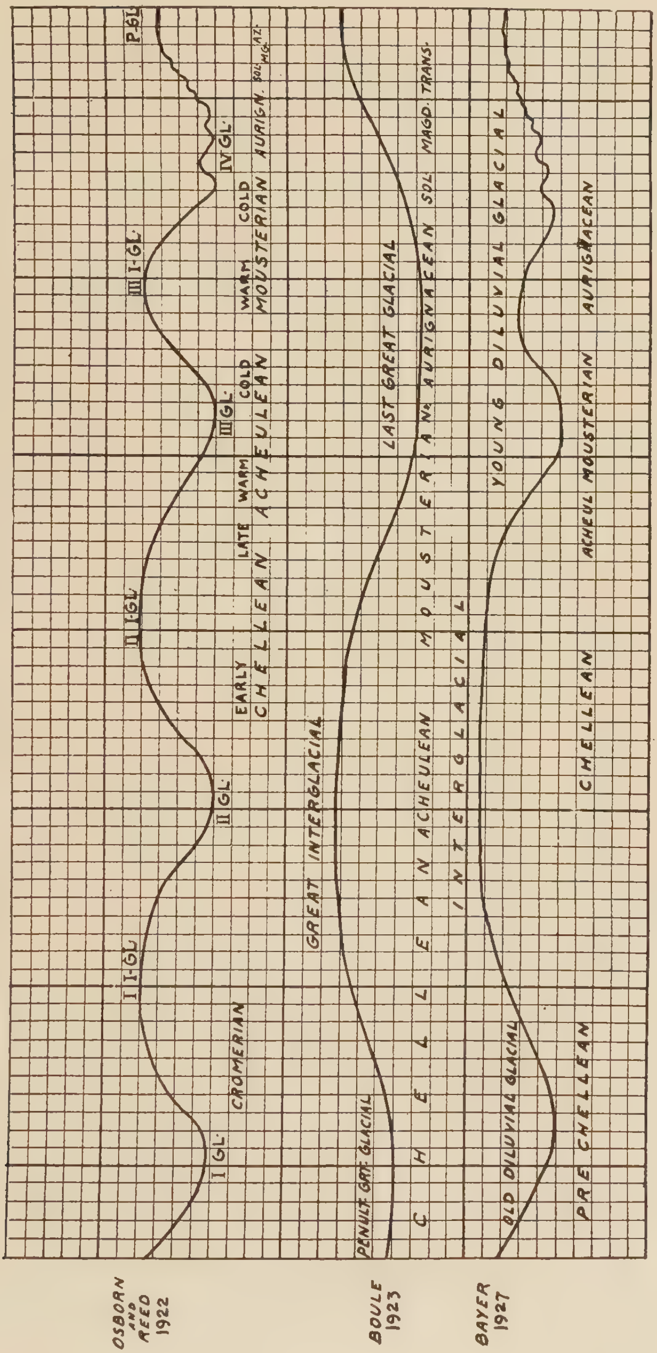

FIG. 3.

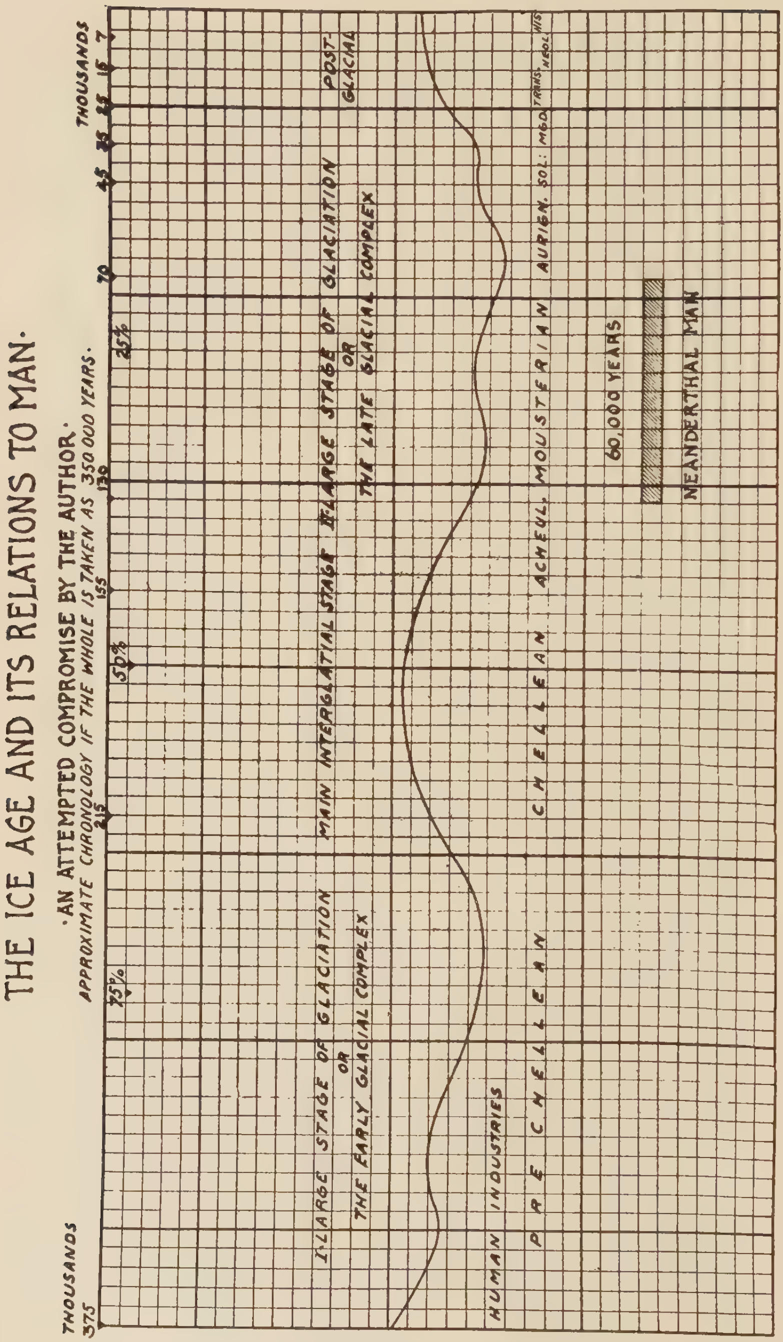
THE ICE AGE AND ITS RELATIONS TO MAN·
·AN ATTEMPTED COMPROMISE BY THE AUTHOR·
APPROXIMATE CHRONOLOGY IF THE WHOLE IS TAKEN AS 350 000 YEARS·
THOUSANDS
375
215
155
130
70
45
35
25
15
7
THOUSANDS
75%
50%
25%
I·LARGE STAGE OF GLACIATION
OR
THE EARLY GLACIAL COMPLEX
MAIN INTERGLACIAL STAGE
II·LARGE STAGE OF GLACIATION
OR
THE LATE GLACIAL COMPLEX
POST-GLACIAL
HUMAN INDUSTRIES
PRE CHELLEAN
CHELLEAN
ACHEUL.
MOUSTERIAN
AURIGN.
SOL:
MGD
TRANS.
NEOL.
HIS
60,000 YEARS
NEANDERTHAL MAN

FIG. 4.

CULTURAL SUBDIVISIONS OF THE PERIOD OF EARLY MAN AND THEIR APPROXIMATE CORRELATION WITH GEOLOGIC CONDITIONS

The beginnings of the ability to shape stones and other objects for his use constitutes one of the essential criteria by which man is separable from his precursors, the others being a habitually upright posture, a complete liberation of the hands, a reduction of the canines and the jaws, a relatively large brain, an articulate language, a dawn of self-consciousness, and progressive association.

The worked stones have been preserved where most other objects have perished, and thus human prehistory is represented principally by stone artifacts. Of these, great numbers have been recovered to date, reaching collectively into the millions, and large accessions are added each year. This vast amount of material covers the entire time of human existence, though naturally the earlier the period, the scantier it becomes; and while in general it progresses in multiplicity of forms and in quality of workmanship, it does not progress evenly, but rather in steps or stages, which, once developed, have usually a prolonged duration. And the principal ones of these stages are utilized, together with such other data as are available, for the subdivision or classification of the prehistoric human period. This classification originated with the earlier prehistorians of France, such as Boucher de Perthes, Gabriel de Mortillet, and many others; and each subdivision received as a rule the name of the locality where first discovered. As time goes on, the stages are seen to be more complex, less regular, and less definitely separable than appeared to the older explorers; nevertheless, the classification substantially holds for western Europe and to some extent perhaps even elsewhere. It is briefly as follows:

CULTURE AND TIME

PALEOLITHIC OR OLD STONE AGE

Eolithic (the "dawn" of stone work; involves much uncertainty)
Pre-Chellean (indefinite both as to time and forms)
Chellean (named after village Chelles, near Paris)
Acheulian (after St. Acheul, a suburb of Amiens)
Mousterian (or *Neanderthal;* latter name applied especially to human skeletal remains of this period, after Neanderthal, valley of the Neander, near Düsseldorf, Germany; "Mousterian" after Le Moustier, a village on the Vezère, Dordogne, France)
Aurignacian (after village Aurignac, southern France)
Solutrean (after a locality north of Lyon, France)
Magdalenian (after "La Madeleine" cave, on the Vezère)

TRANSITIONAL

Azilian-Tardenoisian (first after Mas d'Azil, southern France; second after another locality in France; both somewhat indefinite)

NEOLITHIC OR NEW POLISHED STONE AGE

Various local subdivisions; emerges into historic

COPPER-BRONZE AGE

Early historic

IRON AGE

Historic

The principal forms of the stone implements that characterize these different cultural subdivisions of man's past are shown in many books and other writings on prehistory. So far as contributions in English are concerned, and for details and additional materials the reader must be referred to the reliable recent works of MacCurdy,[1] Burkitt,[2] Miss Boyle,[3] and Peake with Fleure.[4] To a large number of earlier publications references will be found in these authors.

The true geological relation and the exact antiquity of the older parts of man's prehistory is still, it may be repeated, more or less uncertain, due partly to the far from complete archeological and paleontological knowledge, but even more so to the uncertainties about the exact subdivisions and duration of the Ice Age. The charts shown in figures 1, 2, 3, and 4 give approximations of the human and the geological conditions. Such approximations are becoming gradually more and more definite for the period since the greatest intensity of the last glaciation; for the rest of the Ice Age they can only be provisional.

One of the foremost needs and wishes of all who deal with man's antiquity is the possibility of estimation of the different subdivisions of this in years. Geological terms alone do not suffice; what is needed is the application to the various periods of human prehistory of definite and well-known time standards. Sensible of the need, geologists, paleontologists, and prehistorians have for a long time essayed, through the study of erosions and deposits, of the reduction changes in the radio-active elements, of the salt content of the seas, etc., to arrive at such estimates for all geological time[1] and for the Glacial Age in particular. But the results differ so widely that they are of little utility. Thus the estimates of the duration of the Ice Age range from 200,000 (or 250,000 if the first glaciation is included) years by Keith,[2] to 1,000,000 years by Osborn.[3] The estimates for the human periods by these two well qualified authorities are placed here side by side. They show the uncertainties of the case among even the foremost students of the question. To some of the American geologists (*e. g.,* Rollin Chamberlin) the duration of the Ice Age appears even greater than estimated by Osborn.

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[1] MacCurdy, G. G., Human Origins. 2 Vols., New York and London, Appleton & Co., 1924.

[2] Burkitt, M. C., Prehistory. Cambridge, England, University Press, 1921.

[3] Boyle, Mary E., In Search of Our Ancestors. Boston, Little, Brown & Co., 1928.

[4] Peake, H., and Fleure, H. J., The Corridors of Time. A series of 8 small volumes dealing with human prehistory and later stages. New Haven, Yale University Press, 1927-1929.

Conditions are incomparably better, as has already been mentioned, for the time since the maximum of the latest glaciation. Thanks especially to the painstaking researches of De Geer and Antevs, who in addition to other original work have studied the stratified glacial clays in Scandinavia and America, we now know that the length of time elapsed since the cold of the last glacial invasion had reached its maximum amounts close to 35,000 years.

This datum is exceedingly valuable to human prehistory for it corresponds to the latest part of the Mousterian or Neanderthal period of man. The settling of this date, if fully corroborated by future research, establishes a substantial and most important milestone of human chronology, for it clears up the problem of the placing and collective duration of all the following paleolithic cultures, which comprise the Aurignacian, Solutrean and Magdalenian.

A compounding of the various estimates, together with individual studies, has led me to the tentative chronology shown in the following table, the value of which is merely that of a plausible approximation.

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[1] See especially a symposium on The Age of the Earth, by T. C. Chamberlin, J. M. Clarke, E. W. Brown, and W. Duane. Proc. Amer. Philos. Soc., Vol. 61, pp. 247-288, 1922; with further references. Reprinted Smithsonian Ann. Rep. for 1922, pp. 241-273, 1924.

[2] Keith, Sir Arthur, The Antiquity of Man. 3d ed., 2 Vols., London, 1927.

[3] Osborn, Henry Fairfield, Our Ancestors Arrive in Scandinavia. Nat. Hist., Vol. 22, pp. 117-134, New York, 1922; also in Man Rises to Parnassus, p. 106, Princeton, 1927.

CHRONOLOGY, POST-GLACIAL

AUTHOR'S TABLE[1]

Cultural Period, Western Europe	B. C.
Neolithic (regionally variable)	7,000- 2,000
Transitional (Azilian, Tardenoisian)	9,000- 6,000
Magdalenian	14,000- 8,000
Solutrean	15,000-13,000
Aurignacian	30,000-15,000
Mousterian	30,000

[1] It is to be understood that these dates, though based on the approximations by the foremost students of the question and many collateral considerations, are given as no more than mere working suggestions.

Sir Arthur Keith gives a chronology covering the entire human period. The estimates for the postglacial time agree fairly well with those of De Geer and Antevs; but the others are necessarily more doubtful. The estimate for the Mousterian period, in particular, seems to need modification; it appears too short and extends too far forward.

HUMAN CHRONOLOGY

ACCORDING TO SIR ARTHUR KEITH[1]

QUATERNARY:	
Neolithic	2,000- 8,000 B. C.
Azilian	8,000- 10,000 B. C.
Magdalenian	10,000- 13,000 B. C.
Solutrean	13,000- 15,000 B. C.
Aurignacian	15,000- 20,000 B. C.
Mousterian	20,000- 40,000 B. C.
Acheulian	40,000- 80,000 B. C.
Chellean	80,000-120,000 B. C.
Early Chellean	120,000-200,000 B. C.
TERTIARY:	
Pre-Chellean	200,000-300,000 B. C.
Kentish Eoliths	300,000-350,000 B. C.

[1] Keith, Sir Arthur, The Antiquity of Man. Vol I, p. 224; Vol. II, p. 717, London, 1925.

Thanks especially to Drs. Antevs and Leverett, I am able to add several estimates and some notes on the post-glacial time and its relation to man. Added also is a chronological table by Osborn[1] which embodies some individual views of that distinguished author.

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[1] Man Rises to Parnassus, pp. 106-107, Princeton, 1927.

CULTURAL CHRONOLOGY

Denmark

Knud Jessen, 1920[1]

Historic Age	to 1100 A. D.
Iron Age	1100 A. D.- 500 B. C.
Bronze Age	500 B. C.-1500 B. C.
Younger Neolithic Stone Age	1500 B. C.-3500 B. C.
Older Neolithic Stone Age (Aertebølle, Kjøkkenmøddinger)	3500-5000 B. C.
Oldest Neolithic Stone Age (Mullerup, Maglemose)	5000-7000 B. C.

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[1] Jessen, Knud, Bog investigations in North East Sjaelland. Danmarks Geolog. Undersøgelse, Ser. 2, No. 34, Table p. 269, Copenhagen, 1920.

CULTURAL CHRONOLOGY

Sweden

	Sandegren, 1924[1]		Munthe, 1925[2]
Historic Age	to 1000 A. D.		to 1050 A. D.
Iron Age	1000 A. D.- 500 B. C.		1050 A. D.- 800 B. C.
Bronze Age	500 B. C.-1900 B. C.		800 B. C.-1800 B. C.
Stone Cists	2000	B. C. Later Neolithic (2000)-4000	1800-4000
Passage Graves	2500		
Dolmens	3000		
Round Axes	3500		
Old Nordic Stone Age	4500 B. C.		
Epipaleolithic Age (Maglemose)	6000 B. C.		

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[1] Sandegren, Ragnar, Ragundatraktens postglaciala utvecklingshistoria enligt den subfossila florans vittnesbörd. Sveriges Geol. Undersökning, Ser. Ca, No. 12, Table p. 43, Stockholm, 1924.

[2] Munthe, Henrik, Gotlands geologi. Sveriges Geol. Undersökning, Ser. C, No. 331 (Årsbok 18, 1924, No. 3), pp. 74, 76, Stockholm, 1925.

CULTURAL CHRONOLOGY

Northern Europe

De Geer, 1925[1]

Historic Age	to 1050 A. D.
Iron Age	1050 A. D.- 550 B. C.
Bronze Age	550 B. C.-1900 B. C.
Neolithic Age	1900-6800 B. C.
Bone Age	6800-7874 B. C.
Azilian	7874-13,800? B. C.

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[1] De Geer, Gerard, Förhistoriska tidsbestämningar. Ymer, Vol. 45, pp. 1-34, 1925. Reviewed in Geogr. Rev., Vol. 16, pp. 170-171, 1926. See also Osborn, H. F., Our ancestors arrive in Scandinavia. Nat. Hist., Vol. 22, No. 2, pp. 117-134, table p. 123, 1922.

CHRONOLOGY OF WEST ASIATIC, EGYPTIAN, CRETAN, EUROPEAN AND SCANDINAVIAN CULTURES

After Osborn

	B. C.	
	7000	Our ancestors arrive in Scandinavia with large flint implements and axes of reindeer horn
Campignian culture in France, Neolithic culture at Anau, Turkestan	8000	Maglemose (Mullerup) culture of Denmark—Domestic Dog
	9000	Moose (Elk) Period in Scania
Close of Reindeer Period in Southern France	11000	Reindeer Period in Scania
	11500	Final retreat of the Scandinavian Glacier from Southern Scania
Crete settled	12000	
Azilian and Tardenoisian micro-flint industry from Spain and north Africa	13000	
	14000	
	15000	
Magdalenian (Paleolithic) art culture in France. Neolithic culture at Susa, Persia	16000	Reindeer Period in Northern France
	17000	
Beginning of Neolithic in south-western Asia	18000	
Orient and France		Denmark and Sweden

Especially valuable aid in these connections was given to the writer by Professor Frank Leverett, and Dr. Ernst Antevs. Their communications follow. Dr. Antevs' latest chronological tables for Europe are especially serviceable.

Professor Leverett:

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Ann Arbor, Michigan,

November 25, 1928

Dr. Hrdlička:

In reply to your letter of November 17 on chronology of glacial epoch, and recent papers pertaining thereto:

The most important recent contribution is a book by Dr. Ernest Antevs (a student of De Geer) entitled "The Last Glaciation," published by the American Geographical Society, Research Series No. 17, 1928.

Data furnished by Dr. F. W. Sardeson in the Minneapolis-St. Paul Folio of the United States Geological Survey make the date of the final southward flow of the glacial Lake Agassiz, and shifting of the outlet into the Hudson Bay

Basin at less than 10,000 years ago. This being the case the ice sheet persisted west of Hudson Bay down to that time. It is probable that the ice sheet on the Labrador peninsula persisted down to fully as late a time as that west of Hudson Bay.

I have written very little concerning the chronology of the glacial epoch, though I have had considerable correspondence with other glacialists on the subject. I differ from some of them in thinking that there was a prolonged period of extensive glaciation in the Wisconsin or latest glacial stage. I find that the ice sheet continued to grow westward long after the Labrador part had reached its limit at the Shelbyville moraine. As a result the extent or area of the ice sheet may have been greater in what is known as Late Wisconsin time than in the time of the Shelbyville moraine, though its eastern part had shrunk considerably by that time. I am inclined to make the culmination of the ice sheet cover a longer time than that involved in its growth to the Shelbyville moraine. I think the majority of the glacial students, here and in Europe, would make the last glacial stage cover a period of 74,000 to 100,000 years. I think at least 40 per cent of this stage should be allotted to the culmination, and 30 per cent or less to growth to the Shelbyville moraine, and a similar per cent to the departure of the ice sheet, the departure following the development of the Port Huron morainic system (see Monograph 53, U. S. Geol. Survey, for the place of this morainic system).

As to earlier glacial stages, the time involved seems likely to be similar to that involved in the Wisconsin stage as the extent or area covered was but slightly different from that covered in the Wisconsin stage.

The period between the Illinoian, or third glacial stage, and the Wisconsin, or last glacial stage, seems to be somewhat longer than that involved in either of these glacial stages. The basis for estimates is the relative amounts of erosion and weathering each drift has suffered. On this basis it seems safe to put the culmination of the Illinoian at not less than 200,000 years ago.

On the basis of the amount of weathering and erosion displayed by the next older drift, the Kansan, it seems likely to date back at least a half million years. The Nebraskan, or first drift, is much older, but is so largely buried under the later drifts that one cannot well estimate its relative age. But I think it safe to say that it dates back not less than three fourths of a million years.

I trust you will not take these estimates as at all exact in a mathematical sense. They are intended to merely express the general relations in time, though they are based on a study carried on for more than forty years.

Very truly yours,
(Signed) FRANK LEVERETT.

Dr. Antevs·

AMERICAN GEOGRAPHICAL SOCIETY

BROADWAY AT 156TH STREET,
NEW YORK, N. Y.,
NOV. 7, 1928

DR. HRDLIČKA:

I listened with great interest to your lecture in the American Museum of Natural History last Monday and got a much more vivid idea of several problems than I had by reading. Being much interested in coöperation between geology and anthropology, I wish to give some data on the present stand of the absolute clay geochronology. The stand in 1925 is treated in *Geographical Review,* Vol. 15, 1925, pp. 280-284.

What is known in Europe is briefly this:

1. The retreat of the last ice sheet from northeastern Scania, the southernmost province of Sweden, to Stugun in northern Sweden (63° N.) took somewhat more than 4,000 years. The material as a whole is not yet published. The time may be tolerably correct.—De Geer and Sauramo.

2. When the ice edge had reached Stugun the ice rest split in two parts, and this event initiates postglacial age in Scandinavia. Postglacial age began about 8,700 years ago. The material is not published. The figure may be practically correct.—Lidén.

The absolute geochronology in Europe thus takes us more than 4,000 plus 8,700 years back in time, say 13,000 years.

In "On the Solar Curve" (Geograf. Annaler, Stockholm, 1926) and elsewhere Baron De Geer has attempted to extend the European geochronology farther back by correlating varves in Denmark with such in southern Scania. The correlations, however, have no justification, being clearly contradicted by well-known conditions (see for instance Milthers in Geogr. Annaler, Vol. 9, 1927, p. 162). The dating of the Baltic moraine in northern Germany at 18,000 years before our time is only a guess. The correlation of this moraine with the ice edge in Scania is disproven in Denmark.

The release from the ice of northern Germany and the Danish Islands was a very slow affair, as indicated by many morainic lines and readvances of the ice border (most recent summary in my "The Last Glaciation," p. 155).

Varve correlations between North America and North Europe will perhaps never be possible, since the first condition is lacking, viz., knowledge that the summer temperature underwent the same yearly variations in the two areas. The transatlantic varve correlations made by De Geer ("On the Solar Curve" and elsewhere) betray a regrettable ignorance of the geology of North America and disregard for the work done here, besides violating the main principles of varve correlations.

An attempt at correlating the major climatic late Quaternary fluctuations in the main areas of glaciation is made in my Canadian Geol. Survey Mem., 146, 1925, and in the last glaciation.

On the basis of De Geer's, Sauramo's, and Lidén's clay studies in Sweden and Finland and my own in North America, on the estimates based on the Niagara Falls and on my transatlantic correlation I am inclined to place the climax of the last glaciation some 40,000 years back ("The Last Glaciation," p. 168). However, since a restudy of parts of the Niagara gorge (by W. A. Johnston—not yet published) tend to show that it represents shorter time than previously supposed, this figure will perhaps prove to be too large. The maximum of the last glaciation lies perhaps some 35,000 years back in time.

Very sincerely yours,

Ernst Antevs.

LATE QUATERNARY HISTORY OF SCANDINAVIA AND CENTRAL EUROPE

(ERNST ANTEVS, FEBRUARY, 1929)[1]

	Chronology (De Geer, Lidén, Sauramo, etc.)	Climatic periods (Blytt, Sernander)	Typical forests, etc. (von Post)	Stages in the Baltic (Munthe)	Scandinavian cultures (Montelius, etc.)	Stages in last ice retreat The Alps (P.& B.etc.)	Cultural stages in Central Europe
0	1900 A.D.						
					Historic		
1000	1000	Sub-atlantic			1050		Historic
		(Cool, maritime)	Spruce		Iron		
2	Christ			Limnaea			0
					550		La Tène 500 Hallstatt 900 Iron
3	1000	Sub-boreal			Bronze		
4	2 Post-	(Warm, continental)			1800 Stone Cists 2200		Bronze
	glacial Temp. max.				Passage graves		2500
5000	3				Dolmens		Carnacian
		Atlantic	Oak, etc.	Littorina	3500		Robenhausean
6	4	(Warm, maritime)			Pick Kitchen middens	Neolithic	
7	5000				5000		Campignian
8	6	Boreal (Warm, dry)			Maglemosean	Daun ?	Maglemosean
9	8700 7		Hazel, pine, birch	Ancylus	7000		
	9773 ? ? Fini-glacial	Sub-arctic		Yoldia			
10000	8 10070						
	860 (Fenno-Scandian Moraines)	and				Gschnitz ?	Azilian
11	9			Ice lake			
			Dryas				
12	10000 Gothi-glacial	Arctic					
13	11						
14	12 Dani-						
15000	13 glacial					Bühl ?	Magdalenian

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[1] Communicated to the writer.

Dr. Antevs' latest estimates:

STAGES OF LAST ICE RETREAT AND CULTURES

Ernst Antevs, February, 1929[1]

Chronology (Antevs, De Geer, Lidén)		Stages of last ice retreat			Cultures in Central Europe
	Years ago	North America (Antevs)	North Europe (Woldstedt, etc.)	The Alps (P. & B., Hug)	
Gothiglacial	10,000 to 11,000	Cochrane (Ont.)	Fenno-Scand. moraines	Gschnitz	Azilian
Daniglacial	13,500 15,000	S. of Mattawa (Ont.)	Eslöv (Scania)	Bühl	Magdalenian
	20,000			(Achen retreat)	Solutrean
	23,000	St. Johnsbury (Vt.)	Pomerania	Zürich	
	28,000	Middletown (Ct.)	Frankfurt (Poznań)	Schlieren	Aurignacian
	35,000	Long Island	Brandenburg	Killwangen	Late Mousterian

[1] Communication to the writer.

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THE ANCIENT SKELETAL REMAINS OF MAN

However interesting and scientifically valuable the cultural remains of early man may be, the actual parts of the human beings of antiquity, which show what man was scores and hundreds of thousands of years ago, are immeasurably more so. The cultural remains are the indices of man's gradual mastering of nature, of the slow advance in his mentality, and of the eventual unfolding of his esthetic proclivities. But the remains of man himself, though limited to his bones, give us the record of his own amazing differentiation, his evolution. It is insufficient to say that no other range of happenings in nature equals or even approaches in interest and importance that of man's ascent; his evolution can only be adequately described as the paramount phenomenon and achievement of nature.

Regrettably, the skeletal remains of early man are far more scarce than the cultural. Of worked flints not one perhaps has been completely destroyed unless by fire or through man's own activities; but bones are very perishable, and only rare good fortune as to the conditions surrounding them resulted in their preservation. Even then, in a very large majority of cases only some portions of the skull or skeleton escaped destruction, and those that did, have mostly become enclosed in old and now indurated deposits, or even in hard rock, without there being any outward traces of their presence. Thus it is that in general such precious remains are found only by accident, by laborers in excavations or quarrying; and many have been and doubtless still are being lost through damage or inattention. All this is particularly true of the older remains that would be of most importance, and accounts for the scarcity as well as the defects of such discoveries. The object of this treatise will be to give a reliable account of all the more important of these remains based on the original reports, and supplemented by such measurements and data as the writer has personally been able to obtain or corroborate; the utmost effort being made to present records that may be used with full confidence. Where plainly justified, critical remarks will be added, with the avoidance, however, of all personal argument.

TERTIARY MAN

The question as to whether man originated first in the Quaternary or existed already in the latter parts of the Tertiary, is still unsettled.

The problem has been discussed ever since the time of the French pioneers in prehistory. One of the foremost of the earlier protagonists of Tertiary man was Gabriel de Mortillet in France; two of the latest are Reid Moir in England and Henry Fairfield Osborn in this country. The claims for the tertiary existence of man rest essentially on the evidence of apparently worked stones, the so-called "eoliths," in strata that are believed to be of Tertiary age.

There are two serious difficulties in the case. The first is of geological nature and concerns the boundary between the Quaternary and the Tertiary. This boundary is not definite, and the matter is complicated by the tendency of some workers to place the first glaciation in the Tertiary. Not until the geological and paleontological boundaries of the two eras are definitely and generally settled can the question of Tertiary man approach a final solution.

The second and hardly lesser difficulty relates to the apparently worked stones, and consists in the uncertainties as to their true nature. Many of the eoliths resemble intentionally chipped stones, but many flints that evidently came to be chipped by the action of the sun, frost, pressure and incidental violence of various kinds, show more or less similar resemblances. Various criteria for safely distinguishing real from false artifacts have been proposed, but also opposed.[1] There is, it would seem, no valid reason against the existence of some primitive form of man in the upper Tertiary; but before this problem can be definitely settled, generally satisfactory conclusions both as to its geological and its archeological aspects must be reached.

THE JAW OF FOXHALL

The preceding brief reference to the archeological side of the question of Tertiary man seemed called for merely to round out the subject, our real task in this work being the physical remains of man himself.

Only a few human skeletal remains have been attributed to Tertiary man, and none of these has withstood the tests of critical inquiry.

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[1] Consult numerous contributions to the subject in *L'Homme* (G. de Mortillet, 1885, II, 289-299); *Bull. Soc. Anthrop.*, Paris; *Revue d'Anthropologie; L'Anthropologie;* and the periodicals of the Royal Anthropological Institute. The subject is touched upon more or less in every book on human prehistory, and there are many articles relating to it dispersed through the scientific journals of various countries. The most recent yet still not decisive contributions to the subject are those of Osborn, H. F., Recent Discoveries Relating to the Origin and Antiquity of Man, Palaeobiologica, Vol. I, No. 1, pp. 189-202, 1928; and Moir, J. Reid, The Antiquity of Man in East Anglia, Cambridge, 1927.

Only one of these deserves to be dealt with in this place and that only through the prominence given to it by one of the most distinguished of American paleontologists, Henry Fairfield Osborn. The specimen is the Foxhall jaw of southeastern England.

In 1921, at the Washington meeting of the National Academy of Sciences, Professor Osborn expressed his belief that the Foxhall jaw represented a Tertiary man. In the latter part of the same year he wrote an article (published early in 1922) on "The Pliocene Man of Foxhall in East Anglia,"[1] in which he proclaimed his belief in traces of Tertiary man at that locality, but was duly cautious about the jaw, though evidently inclined to the opinion that, if found again, the specimen (now lost) might prove of much value.

During 1923-24, as a result of a visit to Foxhall and to the excavation where the jaw was supposed to have been found, I undertook a study of the find. At my request, Mr. Reid Moir furnished me with all the known details of the discovery, and these, with the original account of the find by Dr. R. H. Collyer and the results of my own study, were published in the American Journal of Physical Anthropology.[2] The main points brought out are as follows:

The "Foxhall jaw" was found in 1855, by workers excavating a bed of "coprolites" near Ipswich, Suffolk. The specimen was purchased from the finder by a local druggist, given by him to Sir Thomas Beaver, in 1857 brought to the attention of Dr. Collyer, an American physician in London. In 1863 Dr. Collyer exhibited the bone to the Ethnological Society of London, and in 1867 published a short account of it[3] in which he plainly endeavors to establish the jaw as very ancient. Eventually Dr. Collyer is believed to have returned to America and probably to have taken the specimen with him; but all further traces of the jaw are since lost.

The only details concerning the circumstances of the find are those given in a letter written eleven years after the discovery by J. Taylor, the druggist, to Dr. Collyer. In this letter he says:

> The history of the matter, so far as I know, is very short.
>
> From what I could learn at the time, from the agricultural laborer of whom I bought it, it came from the coprolite pit on the farm of Mr. Laws at Foxhall, about four miles from Ipswich and was thrown out at Mr. Packard's manure

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[1] Nat. Hist., Vol. 21, pp. 565-576, New York, 1921.

[2] Moir, J. Reid, The human jaw-bone found at Foxhall. Amer. Journ. Phys. Anthrop., 1924, Vol. 7, pp. 409-416; Collyer, Robert H., The fossil human jaw from Suffolk; *ibid.*, pp. 117-120; and Hrdlička, A., Critical notes on the Foxhall jaw; *ibid.*, pp. 420-424.

[3] Anthrop. Rev., Vol. 5, pp. 331-339, London, 1867; republished as in preceding note.

factory with the coprolite from a cart or tumbril, and from thence was brought to me to secure a glass of beer. I had possession of it for near three months, when Sir Thos. Beaver (whose son was then living with me) called on me, and seeing that he exhibited great interest in the inquiry as to the antiquity of the jaw, I had the pleasure of presenting him with it.

There is no doubt the bone was obtained at some depth as I know the pit had been open for a considerable time when it was found.

I visited the coprolite pit in 1855, immediately after it was found, and ascertained that it had been worked for over a year. The place from which "the jaw," in all probability, came was 16 feet below the surface.

Before the publication of his paper Dr. Collyer took the specimen to Richard Owen, the comparative anatomist, "who kept it for two years without coming to any expressed opinion." During the discussion following the presentation of the specimen before the London Ethnological Society, G. Busk, the paleontologist, "pronounced the 'coprolite jaw' in the most summary manner to be 'the jaw of some old woman, perhaps from some Roman burial ground.'" Huxley, after a careful examination of the specimen, which was loaned to him, wrote Collyer as follows: "No doubt, as I stated when you were so good as to show me the jaw, it has some peculiar characters, but they do not appear to me in themselves adequate to lead me to ascribe the bone to an extinct or aberrant race of mankind, and the condition of the bone is not such as I should expect a crag fossil to be." Later[1] Falconer and Busk write: "The specimen is a *very remarkable lower jaw of a human subject* now belonging to Dr. Robert H. Collyer. It is reputed to have been found in the gravel heap of a coprolite pit near Ipswich; although retaining a portion of its gelatine, it is infiltrated through and through with iron. The Haversian cords are filled with red oxide, and a section of the fang shows that the ivory is partly infiltrated with the same metal. This specimen proves that the human jaw, if favorably placed, is equally susceptible of impregnation with metallic matter as the bones of any other mammal." A month later Busk, after a further examination of the bone, writes Collyer: "I have considerably modified the opinion I hastily expressed at the Ethnological Society. That is to say, it is *very different* from an ordinary churchyard bone, though of course, without any relation as regards age with the fossil bones of the coprolite beds; it is of *very great* antiquity, and it is peculiarly remarkable for the great amount of iron it contains, though still retaining about 8 per cent of animal matter. On the whole, therefore, though not of the portentous antiquity it would have claimed had it been contemporary of *Elephas meridionalis*, the 'coprolite jaw' fairly claims a considerable age, and I, for one, am much obliged to you for having brought it under notice, and for the liberal way in which you have allowed it to be examined." Since then the specimen has not been heard of.

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[1] Nat. Hist. Rev., July, 1863, Note 37.

Professor Osborn, in the previously named publication (1921), after reviewing what is known about the specimen, writes as follows: " It would be hazardous for the writer even to express an opinion as to whether this jaw is of Pliocene age. The imperfect figure reproduced on the opposite page shows it to be different from the two most ancient jaws we know, namely, those of the Piltdown and Heidelberg men, for it apparently had a prominent chin. It is possible that the mineralization of the jaw was due to deep intrusive burial. To settle these questions the *jaw must be traced and found.* Even if the jaw proves to belong to *Homo sapiens,* Doctor Collyer's paper has suddenly become a classic because it has led to the long awaited discovery of Tertiary man, which may now be described.

" It remained for Moir, half a century later, to unearth Collyer's paper of 1867, to vindicate his entire procedure, and above all to rediscover the actual *sixteen-foot* level at Foxhall in which Doctor Collyer believed the jaw was located."

Mr. Moir himself, two years later,[1] after similarly reviewing what is known about the jaw, says: " The above account makes it clear that, while there seems much probability for regarding Collyer's discovery as of considerable importance, the fact of this importance is not scientifically established. When all the circumstances of the case are considered, it is not possible to speak of the Foxhall jaw-bone as affording certain evidence of the existence of Tertiary man, nor is it desirable or reasonable that the acceptance or rejection of the flaked flints found by me, under strictly scientific conditions, at the 16 foot level at this place, should be influenced by the specimen described by Collyer."

Discussion.—From all the preceding a number of facts seem clear. The first is that there is no authentic information as to the circumstances of the find. The second is that for eight years the specimen lay unreported; and that when eventually reported, men of the caliber of Owen, Busk, and Huxley were not impressed with its value, though the scientific world just then was quite alert as to the importance of such finds on account of the publicity given to the jaw of Abbeville (Molin Quignon). The bone was " fossilized," through infiltration with red oxide of iron; but such changes are well known to depend on the geophysical and chemical conditions to which a specimen is subjected and are no safe criteria of time.

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[1] Amer. Journ. Phys. Anthrop., p. 416, 1924.

As to the anatomical features of the jaw we have, fortunately, an evidently full-size drawing of the specimen in the Collyer report. This illustration both in form and dimensions indicates a relatively modern jaw. I have gone into this subject as closely as possible in my " Critical Notes " on the jaw (Amer. Journ. Phys. Anthrop., 1924, VII, 422-423) and the details need not be repeated. The results were as follows: All the measurements of the jaw, as deducted from a given dimension and the illustration, agree with those of a more or less modern male bone; and the size and conformation could only be associated with modern-like facial features; none of which is compatible with the notion of any great antiquity. The conclusion was, and remains:

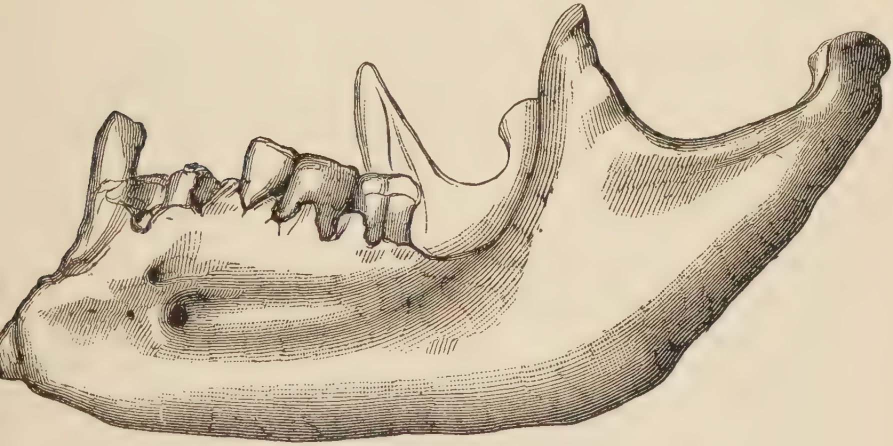

FIG. 5.—Foxhall jaw.

> Taking into consideration the uncertainties regarding the circumstances of the discovery; the good preservation of the specimen in a stratum where all animal bones were reduced to unidentifiable fragments; the considerable amount of animal material which the jaw retained; its form, which showed nothing whatever primitive; and above all its measurements, which all fit among those of ordinary male jaws of recent white man, it may well be asked what remains as a basis on which the Foxhall jaw could receive any further consideration in connection with older Quaternary, not to say Tertiary, man.

Thus the Foxhall jaw fails to establish its right as a representative of Tertiary man. The object of its somewhat extended consideration here is to give an example of a whole category of specimens that have at some time been regarded as very ancient, only to fail on closer examination to sustain this claim. Foremost among them are all the

American " Tertiary " crania and bones, such as the Calaveras skull, the Diprothomo, Tetraprothomo, etc. of Ameghino, and others, in all of which the estimates and identifications were found to be erroneous,[1] and such European specimens as the skulls of Canstadt, Eguisheim, Galley Hill, Tilbury, Ipswich, the jaw of Moulin Quignon, etc., in all of which, it has appeared, the age was much overestimated at first. Human prehistory has its pitfalls, as well as its triumphs.

The Oldest Well-Authenticated Skeletal Remains of Man and Related Forms

THE PITHECANTHROPUS

No finds relating to human prehistory have received more attention and publicity than those attributed to the Pithecanthropus, and none deserved more. Nor are the discussions yet ended. The remains consist, collectively, of a remarkable skullcap, three teeth, a fragment of a lower jaw, and a thigh bone. They were discovered between 1890 and 1897 in Java, by or under the direction of Dr. Eugène Dubois.

Dr. Dubois was appointed to the service in Java as a result of his own efforts. He was already an accomplished anatomist, paleontologist, and student of human ancestry, and he went with the object of searching for possible human ancestors in the East Indies. From 1887 he served as a " Health-Officer of the second class " in the military organization of the Colonies, but a considerable part of his time was devoted to a search of the caves in Sumatra and the collection of fossils. Among the fossils sent to him during this period were a pre-Malay skull collected by van Rietschoten, and some interesting mineralized human bones of "Australoid " type from Wadjak.

In 1889 Dr. Dubois came to Java, and in April of that year he was delegated by the Colonial government, at his own desire, " to extend his studies to the Tertiary and diluvial fauna of Java." [2] From then on until the middle of 1895, the Government Mining Bulletin (" Verslag van het Mijnwezen ") carried quarterly a report by Dubois or others on the progress of his work, and it is in these reports that the original accounts of his very fortunate discoveries are recorded.

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[1] See Hrdlička, A., Skeletal Remains Suggesting or Attributed to Early Man in North America. Bull. 33, Bur. Amer. Ethnol., 1907; Early Man in South America. Bull. 52, Bur. Amer. Ethnol., 1912; also, Bull. 66, Bur. Amer. Ethnol., 1918.

[2] Verslag v. h. Mijnwezen, Batavia, 2 Quart., pp. 18-19, 1890.

Paleontological work in Java had commenced well before the advent of Dubois, and resulted in the discovery in the central parts of the island, more particularly along the Bengawan or Solo river and its tributaries, of fluviatile Pliocene to Pleistocene strata, parts of which proved to be rich in fossil remains of the fauna and flora of those times. In his best early report on these matters,[1] Dr. Dubois gives the following information:

> By order of the Netherlands Indian Government I conducted in Java, from 1890 to 1895, explorations for a fossil vertebrate fauna, of which already some remains had been discovered, many years ago, by Junghuhn and others, and later extensively described by Prof. K. Martin, of Leiden. I found a very large quantity of remains of mammals and reptiles, for the most part derived from extinct species, which show, as might be expected, an unmistakable relation to the later Tertiary and Pleistocene faunae of India.
>
> The chief localities of these finds are in the southern slope of a range of low hills, the Kendengs, which extends between the residences Kediri, Madiun, and Surakarta on one side, and Rembang and Samarang on the other, in a length of about 60 miles. The area in which these vertebrate remains are abundantly found, in many places, may have on an average a breadth of from one to three miles. They are contained in beds of cemented volcanic tuff, consisting of clay, sand, lapilli stone, which especially, through the very general occurrence of the remains of freshwater animals, and of that fluviatile structure which English geologists call current-bedding, or false bedding, prove to be of fluviatile origin. The strata have undergone, in the whole area, considerable disturbances by folding, on account of which they have, from east to west, dips of 3° to 15° in a general southerly direction. The whole formation reaches a maximum thickness of more than 350 meters. The strata rest, unconformably, upon beds of marine marl, sand, and limestone, recently determined by Prof. K. Martin to be of Pliocene age. The fossil vertebrate fauna, which they contain, is everywhere in the Kendeng, and also in other places in Java, the same, and a homogeneous one. Its age can only be judged when the description of my collection, which I intend to give in the course of a few years, shall be published. But I have studied it already a little, and it can be said, in accordance with geological circumstances, and the relations which this fauna has with the Post-Tertiary and Pleistocene vertebrate faunae of India, that, most probably, it is young Pliocene; in no case, however, can it be younger than the oldest Pleistocene. For, whilst on the one hand the species surely belong almost exclusively to living genera—only the genus *Leptobos* and the sub-genera *Stegodon* and *Hexaprotodon* are extinct—and it must therefore be younger than the principal part of the Upper Miocene or Lower Pliocene Siwalik-fauna, including not a few extinct genera; on the other hand, the number of the extinct species seems to be in proportion somewhat greater than that of the Narbadá-fauna, which is put in the early Pleistocene. Further, the inclination which the strata show does not well agree with a Pleistocene age. . . . .

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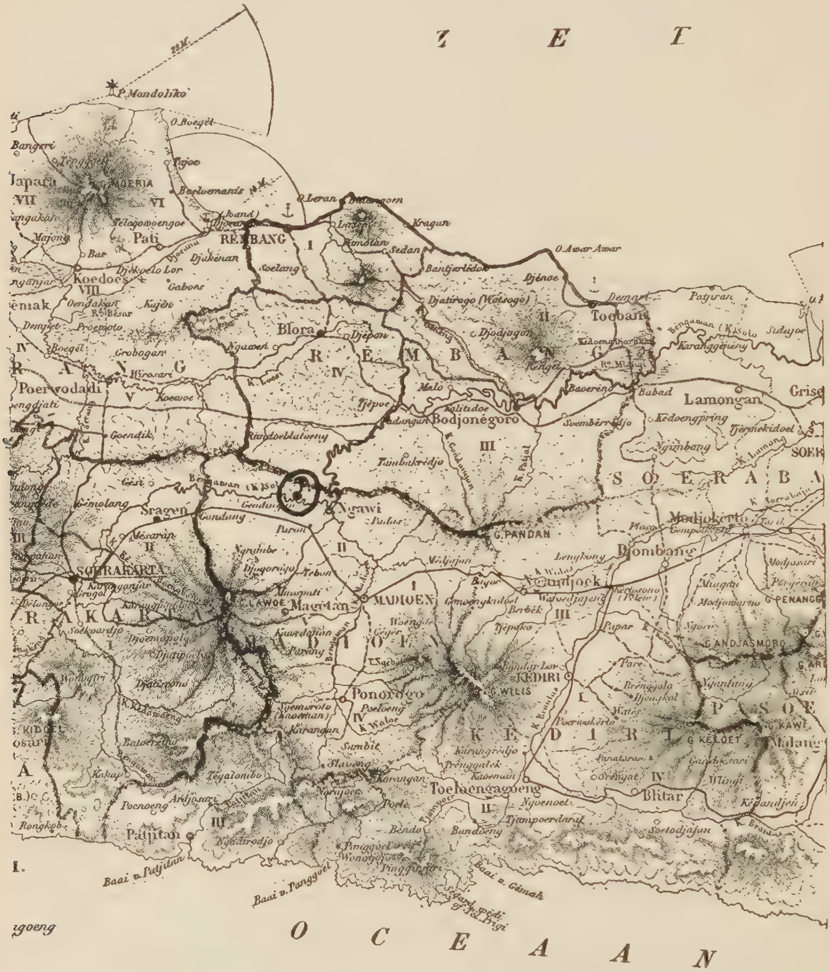
[1] Dubois, Eugène, On *Pithecanthropus erectus:* A Transitional Form Between Man and the Apes. Sci. Trans. Roy. Dub. Soc., Dublin, Vol. 6, ser. 2, pp. 1-18, 1898.

SIOUX CITY, IOWA

From Trinil to Ngawi the steep banks of the Bengawan or Solo river, for an extent of 7½ miles, consist exclusively of the above-mentioned volcanic sands and lapilli, cemented into soft rocks, very much like the rocks which I saw in the Siwalik hills. The strata have in this area a general dip S. of about 5°, and are only concealed by a thin covering of vegetable soil. In these strata the Solo River has cut its channel 12 to 15 meters deep near Trinil. North and west of Trinil the Pliocene marl and limestone appear under them.[1]


Z E E
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S O E R A B A
Sragen
Ngawi
G. PANDAN
Modjokerto
Djombang
SOERAKARTA
G. LAWOE
Magetan
MADIOEN
Ngandjoek
KEDIRI
G. WILIS
Ponorogo
K E D I R I
G. KELOET
Malang
Blitar
Toeloengagoeng
Patjitan
G. ANDJASMORO
G. KAWI
Baai v. Patjitan
Baai v. Panggoel
O C E A A N

FIG. 6.—Central part of Java, showing the Solo (Bengawan) River and the site of the Pithecanthropus.

It was near Trinil, in the left bank of the river, at the foot of the Kendeng, that I came, in August, 1891, upon a place particularly rich in fossil bones, and found there, in that and the following year, among a great number of remains of other vertebrates, bones and teeth of a great man-like mammal, which I have named *Pithecanthropus erectus,* considering it as a link connecting together Apes and Man. . . . .

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[1] See also Dubois, Smithsonian Rep. for 1898, pp. 446-447.

Among hundreds of other skeleton remains, in the lapilli bed on the left bank of the river, the third molar tooth was first found in September; then, the hole having been enlarged, the cranium a month later, at about 1 meter distant from the former, but in the very same level of that bed. The species of mammals, of which remains were found in the same bed, are, for the greater part at least, extinct ones, and almost certainly none of them are at present living in Java. Among these remains we find a great number of the above-mentioned small species of *Cervus,* which certainly is not extant in the Malayan isles. Also many bones of *Stegodon* were found. One or two *Bubalus* species seem to be identical with Siwalik species; a *Boselaphus* undoubtedly differs from the known species, living and fossil. Further on there were found the extinct genus *Leptobos,* the genera *Rhinoceros, Sus, Felis, Hyaena,* and others; a Garial and a Crocodile, differing little from the existing species in India, but which cannot be classed among them.

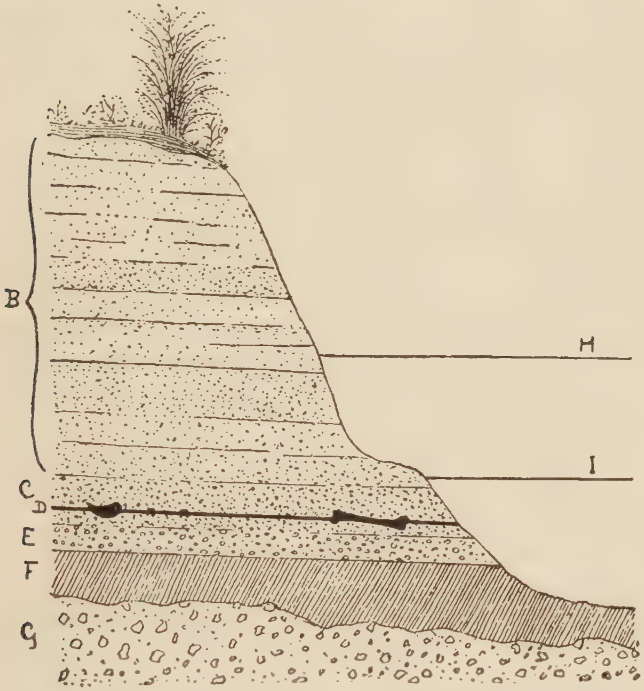

Fig. 7.—Ossiferous strata in which the Pithecanthropus bones were discovered. *B,* soft sandstone; *C,* lapilli stratum; *D,* level at which the skeletal remains were found; *E,* conglomerate; *F,* argillaceous layer; *G,* marine breccia; *H,* wet-season level of the river; *I,* dry-season level of the river.

Of the animals found in the same strata in other places, the most interesting species are a gigantic Pangolin (*Manis*), three times as large as the existing

Javanese species, and a Hippopotamus belonging to an extinct Siwalik subgenus. Further a Tapir and an Elephas.

The work having been brought to an end that year on account of the setting in of the rainy season, it was taken up again at the beginning of the dry season in May, 1892. A new cutting was now made in the left rocky bank, which comprised the still unfinished part of the old excavation. Thereby bones were again found in great numbers, especially in the deeper beds; and among these, again in the same level of the lapilli bed, which had contained the skull-cap and the molar tooth, the left femur was found in August, at a distance of about 15 meters from the former; and at last, in October, a second molar, at a distance of 3 meters at the most from the place where the skull-cap was discovered, and in the direction of the place where the femur had been dug out. This tooth I did not describe, because I only found it later among a collection of teeth derived from the place stated above.

As a matter of fact at the time the first of the just mentioned remains were discovered, Dubois was already in possession of a fragment of an old lower jaw found early in 1890 in the fossiliferous layers of the Kendeng formation at one of the tributaries of the Bengawan river.

The total Dubois finds eventually attributed by him to the Pithecanthropus, and still in his possession, comprise the just mentioned lower jaw, the 1891-93 Trinil finds of two molar teeth, a skull-cap and a femur, and another tooth, a premolar, discovered in the Trinil deposits several years later.

These remains are all of such importance that they deserve separate and detailed attention.

THE FIRST FIND: THE LOWER JAW

The history of the Dubois find as thus far given in scientific literature is more or less incomplete. The details, as obtainable from the original sources, were as follows:

The first note of importance is found in the report for the first quarter of 1890.[1] Dr. Dubois announces that he had discovered, on November 24, 1890, in the so-called Kendeng deposits of the watershed of the Bengawan river, among typical remains of the old fauna and in the same sandstone-like andesite tufa, a human fossil, consisting of a fragment of a lower jaw, with the alveoli of the canine and the first and second premolars. The specimen leaves no doubt, he states, as to its human derivation. Its chin may have been even less prominent than that in the diluvial European jaws of LaNaulette or Šipka and possesses a remarkable flattening as well as hollowing out for the attachment of the digastric muscle, of a different type from those known so far. The man represented by this fossil lived in Java with the stegodont elephants and other extinct animals at the time when Java was still united with Asia.

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[1] Verslag v. h. Mijnwezen, Batavia, pp. 14-15, 1891. See also Natuurk. Tijdschr. Nederl. Indie, Vol. 51, p. 95, 1892.

The find of the lower jaw is also mentioned by Dubois in the "Natuurkundig Tijdschrift voor Nederlandsch-Indië" of 1891. He then considered the jaw as "a remain of a not exactly determinable human species," and of "another and probably lower type" than both the modern jaws and those that existed in the European diluvial times.

There is no further report on the fragment and it seems to have been forgotten by scientific men. But in his latest report on the skull (1924)[1] Dr. Dubois devotes a few lines again to the specimen, and a little later publishes illustrations of it.[2]

In this latest report, on page 266, Dubois states that the fragment was found near Kedung (=river) Brubus, in the same Kendeng layers that gave the remains of the Pithecanthropus; on page 274, he adds: "A mandibular fragment, a small piece on the right of the symphysis, was found in the same Kendeng-layers, but at 40 km. distance on the E. S. E. of Trinil, namely at Kedung Brubus, among other fossil remains of the Kendeng fauna. Its specific gravity is the same as that of the teeth and the other remains of Pithecanthropus." And a little further: "The mandibular fragment is a scalene-triangular piece of the corpus mandibulae, with a basis of 36 mm. (measured rectilinearly) of the lower border, immediately on the right of the symphysis. The apex is formed by the root of the anterior premolar tooth, which root has been preserved for the greater part. It is there 30 mm. high. There further is preserved the back half of the flat alveolus of the caninus with its root point and part of the front plane of the alveolus of the posterior premolar tooth, under which is situated the front edge of the foramen mentale, 12 mm. above the sharp lower border. In its full thickness the corpus mandibulae has only remained preserved at the septum of the alveoli of the caninus and the anterior premolar tooth. I now ascribe also this mandibular fragment to *Pithecanthropus erectus,* because what the teeth teach us is quite corroborated by the morphological characters of this small, but all the same very significant piece of the mandible."

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[1] On the Principal Characters of the Cranium and the Brain, the Mandible and the Teeth of *Pithecanthropus erectus.* Proc. Acad. Sci., Amsterdam, Vol. 27, Nos. 3 and 4, pp. 265-278, 1924.

[2] Figures of the Calvarium and Endocranial Cast, a Fragment of the Mandible and Three Teeth of *Pithecanthropus erectus. Ibid.,* Nos. 5 and 6, pl. 8, with text figures.

H. Weinert, the foremost present German student of early skeletal remains of man, has studied the original fragment and reports upon it in his recent meritorious work on the Pithecanthropus.[1] His first word is: "With this fragment begin our difficulties as to the meaning of the Pithecanthropus finds." It is to be recalled that the fragment came from the same geological deposits as at Trinil though at some distance away, that it was accompanied by the same Kendeng fauna, and that the bone has the same general aspect, color, and specific gravity as the Pithecanthropus remains from Trinil. Moreover, the root of the premolar of Trinil shows dimensions closely resembling those of a corresponding tooth in the lower jaw. All of which influenced Dubois in attributing the fragment to the genus Pithecanthropus. Yet the evidence for this is not decisive. Weinert gives several useful measurements of the fragment. They are as follows:

Height of body between canine and first premolar	27.8 mm.
Greatest thickness of the bone at same place, at right angles to the height	14.4 mm.
Depth of the alveolus of the canine, near	14.0 mm.

There was no broad distance between the canine and the premolar, the breadth of the septum between the two alveoli amounting to 14.5 mm. The canine evidently was human rather than anthropoid.

Small as the fragment is, it nevertheless shows marked differentiation in the sharp external border and the long and broad flattening of the under surface for the insertion of the digastric muscle. The symphysis, however, was human-like and apparently already possessed a slight chin.

Considering the fragment alone, Dr. Weinert sees hardly any other possibilities than that of regarding it as human. Had it been found in Europe, it probably would have been attributed to the Neanderthal stage. As it is, neither the circumstances of its discovery nor the chemical, physical, and morphological characteristics of the specimen permit its definite classification. It appears somewhat more human than, judging from the skullcap, would have been expected for the Pithecanthropus. But conclusions one way or the other will only become possible through further discoveries.

The writer saw the fragment in 1923. Unfortunately so little is left that, as later found by Weinert, definite conclusions appear for the present impossible. The piece, while clearly belonging to a human-like mandible, conveys a strong impression of primitiveness, particularly in regard to the lower border. This border presents a remarkable, sharply-bound, flat plane, of which I have never seen a counterpart in human jaws, not even in those of the Neanderthal and other old periods. Nevertheless intimate association of this lower jaw with the other remains attributed to the Pithecanthropus must for the time being remain merely conjectural.

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[1] Weinert, Hans, *Pithecanthropus erectus.* Z. Anat. u. Entwicklungsgesch., Vol. 87, pp. 522-524, 1 fig., 1928.

THE FINDS AT TRINIL

THE FIRST TOOTH

The first report by Dr. Dubois on the finds relating more directly to the Pithecanthropus, appears in his chapter on " Palaeontological Researches," in the " Verslag van het Mijnwezen," Batavia, for the third quarter of 1891, pp. 13-14. Speaking of the work near " Tinil " (later Trinil), he says: " The most remarkable find however was a molar (the upper third permanent molar of the right side) of a chimpanzee (*Anthropopithecus*). This genus of anthropoid apes, now found only in the western and central equatorial Africa, lived in the Pliocene in India and also, as this discovery shows, in the Pleistocene period in Java."

THE SKULLCAP

In his report for the fourth quarter of 1891 (*ibid.*, 13-15). Dr. Dubois announces the discovery of the skullcap, gives the first notes and measurements on it, and attempts its classification. The communication is of much interest. He says: " The Pleistocene fauna of Java, which in September of this year was augmented by a molar of a chimpanzee, was much further enriched a month later. Close to the spot in the left bank of the river where the molar appeared, there was unearthed a fine skullcap which, with even less doubt than the molar, may be attributed to the genus *Anthropopithecus troglodytes*. That both the specimens come from a great manlike ape, is at once clear. The tooth differs from the third upper molar of the living chimpanzee only by a slightly greater size. The skull may readily be distinguished from that of the orang through its greater dolichocephaly, and from that of the gorilla through the absence of cranial crests, which are so pronounced in this most bellicose of the living anthropoids and are also still fully represented in the chimpanzee. About the genus [of the form represented by the new finds] there can thus be no doubt. As to the species, the skull differs from that of the living chimpanzee by its greater size and its higher vaulting. Its greatest length is 18.2 cm., greatest breadth 13.3 cm."

The question of the species of the new "Pleistocene chimpanzee of Java" (p. 15) is undecided; but it is plain that while the living and also the India fossil chimpanzee, in their denture, approach man more than the orang or the gorilla do, the fossil chimpanzee of Java comes nearer to man also in the form of his skull.

THE FEMUR

The next note of much interest by Dr. Dubois is found in his report for the third quarter of 1892 (Verslag v. h. Mijnwezen, 1893, pp. 10-14). He here announces the discovery, in August, 1892, of the femur, and gives the form represented by the finds its first specific name. The femur was discovered, he states, at the same level as the skullcap and tooth, but 15 meters (nearly 50 ft.) further upstream; and it is plain to him that the three specimens, the tooth, skullcap and femur, belong to the same individual, probably a female of advanced age. Through this find it is now clear, he believes, that the "old Pleistocene" Javanese "*Anthropopithecus*," whose skull shows it to have been the highest of the thus far known anthropoids, had also already assumed completely the upright posture. "Through each of the three recovered skeletal parts, and especially by the thighbone, the *Anthropopithecus erectus* Eug. Dubois approaches man more closely than does any other anthropoid."

The skullcap receives here further consideration. Its measurements (slightly different from the first) are: greatest length 18.5 cm.; greatest breadth 13.0 cm.; capacity about 2.4 times that of the living chimpanzee and about $\frac{2}{3}$ that of man. The skull in its form and other characters stands close to the genus *Anthropopithecus* (but also nears that of *Hylobates*), and is distinguished by its large size, its marked vaulting, and the relatively small development of its supraorbital arch. The tooth in some respects is more advanced than those of the chimpanzee and gibbon; in other respects it comes nearer to the teeth of those animals than of man. The femur is remarkably human-like, with a few differences. Its bicondylar length is 45.5 cm., the relation of the thickness of the shaft at middle to the length is as $16\frac{1}{2}:1$. "The characters of the bone make it certain that the Javanese *Anthropopithecus* stood and walked equally upright as man," and that his hands and arms were free. Considering the apparently late appearance of man (p. 14) "it seems therefore quite possible that man has evolved from this old-Pleistocene *Anthropopithecus erectus*. And thus is also furnished an adverse proof to the opinion, expressed by some, that India was the cradle of man."

THE SECOND TOOTH

No original report on the second molar attributed to the Pithecanthropus was located. It is not mentioned in the first accounts. However in his report for the fourth quarter of 1892 (*op. cit.*, 1893, pp. 11-12) Dr. Dubois relates that the excavations at the Trinil site, where were discovered the remains of the " remarkable anthropoid," were continued till the middle of November, when rains made further work impossible. Among the fossils recovered was also a molar tooth " that probably belonged to a Cynocephalus." This may have been the tooth in question, for in 1895-1896 Dr. Dubois writes[1] that the second Trinil molar was discovered in October of 1892 at a distance of three meters (9.8 feet) from the original position of the skullcap and in the direction of the resting place of the femur.

THE THIRD TOOTH

The discovery of this tooth was made known by Dr. Dubois, through a communication read by Duckworth, at the General Meeting of the Fourth International Congress of Zoology, Cambridge, August 26, 1898. An account of this communication in the Journ. Anat. & Physiol., 1899, Vol. 33, 273, reads as follows:

> The speaker [E. Dubois] announced the discovery, during the past year [apparently therefore 1898], of another tooth referable to *Pithecanthropus erectus*, in further excavations at Trinil in Java, made under the speaker's direction. This tooth is remarkable as being the second left lower premolar, the tooth already found having belonged to the upper jaw. The fact that it was discovered in that part of the sandstone formation immediately adjoining the site of the other remains of *Pithecanthropus erectus* affords additional argument in favor of the individual identity of origin of all.

LATER EXCAVATIONS AND STUDIES

With the season of 1893 the excavations at Trinil came to an end; 1894 was given by Dubois to the study of the specimens and the publication of his important report; early in 1895 he made a trip to India and the Siwaliks, for comparative studies; during 1894-95 his large paleontological collections were sent to the Rijks Museum of Natural History at Leyden; and towards the end of the second quarter of 1895, Dubois himself departed for Europe (*Versl. Mijnwz,* 1894-95.)

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[1] Dubois, E., On *Pithecanthropus erectus:* A Transitional Form between Man and Apes. Trans. Roy. Dubl. Soc., Vol. 6, Pt. 1, 1896; also under same title, Journ. Anthrop. Inst., Vol. 25, p. 242, 1896. See also C. R. III. Congr. Zool., Leyden, pp. 254-255, 1896.

Some further excavations at Trinil, during the dry seasons, were nevertheless carried on under the direction of Dubois until 1901, but they yielded, so far as anthropoid or human-like remains are concerned, only the premolar tooth, the find of which was reported in 1898, as mentioned above, to the Fourth International Congress of Zoology at Cambridge, England.

Shortly after his return, Dubois made a trip to Paris to show the specimens to Manouvrier, and the occasion, as narrated to me by Manouvrier, later my esteemed teacher and friend, nearly proved disastrous to the bones.[1]

THE OPINIONS OF DUBOIS AND OTHERS REGARDING THE REMAINS

In 1894 Dubois' first important report on the Trinil remains appears under the title "*Pithecanthropus erectus,* eine menschenähnliche Uebergangsform aus Java," 40 pp., 3 figs., 2 pls. (Batavia Landes Druckerei; reprinted 1915 by G. E. Stechert, N. Y.)

In this he characterizes the new form as follows:

Order: Primates
New Family: *Pithecanthropidae* .

Skull ("Hirnschädel"), absolutely as well as relatively to stature much more spacious than that of the *Simiidae,* but less spacious than in the *Hominidae;* skull capacity about two-thirds of the average capacity in man. Inclination of the lower surface ("Neigung der Nackenfläche") of the occipital bone markedly stronger than in the *Simiidae.* Teeth, although reduced ("in Rückbildung"), still of the type of the *Simiidae.* Femur equaling the human in dimensions and, like the human, developed for an upright posture.

In the same original, able and painstaking memoir, Dr. Dubois (p. 4) gives his principal measurements of the skull and corresponding measurements of four chimpanzees and two gibbons. These original measurements deserve to be reproduced:

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[1] The incident deserves to be mentioned—if only as a part of the already rich romance of prehistory. Dr. Dubois, according to Manouvrier, brought the specimens in a hand satchel. After discussing them with Manouvrier in the Laboratory, the two went to a nearby restaurant for supper. And so absorbed did they become in argument that as they left, the satchel was forgotten under the table. And they went some distance, still discussing, before Dubois suddenly missed his bag. There was little time lost in returning to the restaurant where, as the good guardian angel of the Pithecanthropus would have it, and perhaps because of the late hour, the satchel was still in its place. Nor is this the last piece of romance relating to these remains, as will be seen later.

	Pithecanthropus erectus	*Anthropopithecus troglodytes*				*Hylobates syndactylus*		*Hylobates agilis*
		♂ Owen	♂ Bischoff	♀ Bischoff	♀ Dubois	♂I	♂II	♂
Länge des Gehirnschädels	185	134	137	138	132	100	93	85
Grösste Breite des Gehirnschädels	130	...	98	97	91	70	68	62
Breitenindex	70	...	71.5	70	69	70	73	74
Temporale Breite	90	68	...	...	66	52	48	50

Other measurements are given in the text (especially p. 11). The cranial capacity was estimated at somewhat over 1,000 cc. (p. 11). The characteristics of the skull indicated, Dr. Dubois believed, that it "represented a form which must be classed in a different genus from those of Gorilla, Orang and Man"; it "approaches the skull of Man in its approximate size and its vaulting, showing, nevertheless, considerable resemblances to that of the chimpanzee and in form to that of the gibbon." The various characteristics of the fossil skull indicated that it belonged to a female individual.

The femur, according to Dubois, showed close resemblances to that of man, although also some differences. Its bicondylar length was 45.5 cm. which, he believed, equaled that of a man of about 170 cm. in stature. The shaft was less curved forward than in man, and approached less the prismatic form. The circumference of the bone at the middle was 9.0 cm., its lateral diameter 2.75 cm., both much as in man. The popliteal plane, however, instead of being slightly concave or nearly flat as in man, is perceptibly convex; this character is never met with in human femora. The angle of the neck, 175°, is near the average in man. The transverse and vertical diameters of the head are respectively 2.25 and 2.15 cm., agreeing closely with human dimensions. The intertrochanteric ridge differs from that in man, approaching that in an orang. The rest of the characteristics of the bone are essentially human-like, with here and there some deviation. The form of the lower articulation is as in man and unlike that in any of the anthropoid apes.

Judging from the length and strength of the bone Dubois believed himself justified in assuming that the upper part of the body of the

Pithecanthropus could not have been much different from that of man of today, and that the height of his body approximated 170 cm. (5 ft. 7 in.). The being had a completely upright posture and walked habitually erect, which indicates at the same time a human-like freedom of the arms and the hands.

All the above showed conclusively to Dubois that the form could not be ascribed to the *Simiidae;* at the same time, numerous characteristics of the skull, those of the teeth, and some features even of the femur indicate that the form cannot be classed with those of the *Hominidae.* It is an intermediary form which necessitates its classification as a new genus, the *Pithecanthropus,* and a new family, the *Pithecanthropidae. Pithecanthropus erectus* is a transitional form which must have existed between man and the anthropoids; "it is the precursor (Vorfahr) of man" (p. 31). The inner and posterior of the upper fourth of the femur show a pronounced exostosis of pathological origin. Similar exostoses are known in man.

Dubois' reports on the Java finds, and above all the specimens themselves after he brought them to Holland, attracted naturally the liveliest attention of the scientific world. A number of prominent anthropologists, paleontologists, and anatomists, such as Manouvrier, Marsh, Flower, Virchow, Smith Woodward, Sir William Turner, Schwalbe, and others, were given the privilege of seeing the specimens; and September 15-21, 1895, the originals were exhibited to all before the Third International Zoological Congress at Leyden, where they received great attention and much discussion. On December 14, 1895, the originals were shown again by Dubois, who at the same time presented a report upon them, at a special meeting of the Berliner Gesellschaft für Anthropologie; and before long several bronze replicas were made of the skull for distribution to a few Institutions (one is at the Laboratoire d'École d'Anthropologie, Paris), from which in turn were obtained plaster casts that became generally available.

Soon, also, discussions of the subject by various workers began to appear in various scientific media. Two communications by Manouvrier appeared in January and February, 1895,[1] followed rapidly by those of Cunningham,[1] Turner,[2] Krause,[3] Martin,[4] a series of articles by Virchow,[5] another communication by Dubois,[6] and another by Manouvrier.[7]

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[1] Manouvrier, L., Le *Pithecanthropus.* Rev. mens. École Anthrop., Paris, Vol. 5, pp. 69-72, 4 figs., 1895.

———. Discussion du "*Pithecanthropus erectus*" comme précurseur présumé de l'homme. Bull. Soc. Anthrop. Paris, Vol. 6, pp. 12-47, 6 figs., 1895 (presented in January of same year, but not published until several of the following papers appeared).

Since then many articles and notes have been published on these remains. Their bibliography alone would fill many pages.[8] There is much of controversy, but little original until we reach the exhaustive study of Schwalbe, 1899.[9]

Dubois' discovery was universally acknowledged as one of great importance; but his views were soon combated. The case presented two main problems. The first was the question of whether the several parts, *i. e.*, the skull, the two teeth, and the femur, belonged to the same individual or at least to the same form; the other, that of the identification of this form.

Dubois believed, as has been seen, that all four specimens, namely the skull, the two teeth, and the femur, belonged to one stratum, one age, and one individual, a female *Pithecanthropus erectus*. To this there were soon many objections. The conclusions of Manouvrier, the foremost anthropologist of France (Bull. Soc. Anthrop., 1895, 46, 648, 658), were cautiously favorable to those of Dubois. But Cunningham, Turner, Virchow, and others dissented. In 1896 Marsh, in discussing the find in The American Journal of Science,[1] was already able to enumerate the following objections of various authors (p. 476): " . . . . the various remains discovered were human, and of no great age; that they did not belong to the same individual; that the skull apparently pertained to an idiot; and that both the skull and femur showed pathological features."

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[1] Cunningham, D. J., Dr. Dubois' So-Called Missing Link. Nature, Vol. 51 pp. 428-429, 1895.

[2] Turner, Wm., On M. Dubois' description of remains recently found in Java, with remarks on so-called transitional forms between Apes and Man. Journ. Anat. and Phys., Vol. 24, p. 424, 1895.

[3] Krause, W., with Luschan, V., Virchow, R., and others, *Pithecanthropus erectus,* Verh. Berl. Ges. Anthrop., Z. Ethnol., Vol. 27, pp. 79-88, 1895.

[4] Martin, R., Kritische Bedenken gegen den *Pithecanthropus erectus* Dubois. Globus, Vol. 67, p. 213, 1895.

[5] Virchow, R., *Pithecanthropus erectus* Dubois. Verh. Berl. Ges. Anthrop., Z. Ethnol., Vol. 27, pp. 336-337, 435-440, 648-656, 723, 744-747, 787-793, 1895 ("Exostosen und Hyperostosen von Extremitätenknochen des Menschen; im Hinblick auf den Pithecanthropus").

[6] Dubois, E., *Pithecanthropus erectus,* betrachtet als eine wirkliche Uebergangsform und als Stammform des Menschen. Discussion by Nehring, Kollman, Virchow, and Jaekel. Verh. Berl. Ges. Anthrop., Z. Ethnol., Vol. 27, pp. 723-749, 1895.

[7] Manouvrier, L., Deuxième étude sur le "*Pithecanthropus erectus*" comme précurseur présumé de l'homme. Bull. Soc. Anthrop. Paris, Vol. 6, pp. 553-651, 1895. Also Moulages du crâne et des dents du *Pithecanthropus. Ibid.,* pp. 658-659.

[8] See especially Miller, Gerrit S., Jr., The controversy over human "missing links." Ann. Rep. Smithsonian Inst. 1928, pp. 447-457.

[9] Schwalbe, G., Studien über *Pithecanthropus erectus* Dubois. Z. Morphol and Anthrop., Vol. 1, pp. 1-240, 1899.

———. *Pithecanthropus erectus,* eine Stammform des Menschen. Anat. Anz., Vol. 12, pp. 1-22, 1896. Published also, translated, under the title of "*Pithecanthropus erectus:* A Form from the Ancestral Stock of Mankind," Smithsonian Rep. for 1898, pp. 445-459, 3 pls., 1900.

For himself Marsh says (p. 482):

> After a careful study of all the *Pithecanthropus* remains and of the evidence presented as to the original discovery, the position in which the remains were found, and the associated fossils, my own conclusions may be briefly stated, as follows:
>
> The remains of *Pithecanthropus* at present known are of Pliocene age, and the associated vertebrate fauna resembles that of the Siwalik Hills of India.
>
> The various specimens of *Pithecanthropus* apparently belonged to one individual.
>
> This individual was not human, but represented a form intermediate between man and the higher apes.
>
> If it be true, as some have contended, that the different remains had no connection with each other, this simply proves that Dr. Dubois has made several important discoveries instead of one. All the remains are certainly anthropoid, and if any of them are human, the antiquity of man extends back into the Tertiary, and his affinities with the higher apes become much nearer than has hitherto been supposed.

The dissenting opinions of some of the greatest scientific authorities of the time, anatomists, anthropologists, and paleontologists, deserve to be quoted.

Cunningham:[2] As a result of his study and comparisons this author reaches the conclusion that " the fossil cranium described by Dubois is unquestionably to be regarded as human. It is the lowest human cranium which has yet been described. It presents many Neanderthaloid characters, but stands very nearly as much below the Neanderthal skull as the latter does below the ordinary European skull. . . . ."

As to the femur " that it is human in every respect, no one could for a single moment doubt. . . . . From the fact of the femur being found at a distance of from 12 to 15 m. from the place where the cranium was discovered, as well as from other considerations, it is very unlikely that the two specimens belonged to the same individual."

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[1] Marsh, O. C., On the *Pithecanthropus erectus*, from the Tertiary of Java. Amer. Journ. Sci., Vol. I, pp. 473-482, 1896.

[2] Cunningham, D. J., Dr. Dubois' So-Called Missing Link. Nature, Vol. 51, pp. 428-429, 1895.

The fossil tooth (r. u. M 3), while very remarkable, "is fashioned more after the human model than simian.

"From what has been said, it will be seen that the skull and the tooth, even granting that they are from the same individual, present no such characters as would warrant the formation of a new family. The cranium at least is undoubtedly human. Most certainly they are not derived from a transition form between any of the existing anthropoid apes and man; such a form does not and cannot exist, seeing that the divarication of the ape and man has taken place low down in the genealogical tree, and each has followed, for good or bad, its own path. The so-called Pithecanthropus is in the direct human line, although it occupies a place on this considerably lower than any human form at present known."

For Sir William Turner,[1] it was not at all certain that the three bones belonged to the same creature. A comparison of the skull with several specimens of the skulls of aboriginals, left him unconvinced that it might not have belonged to a human being. The features of the femur could all be made out in a large collection of human thigh bones, and the tooth had quite as much resemblance to the tooth of a human being as to the tooth of an ape. He considered that the remains were of a low human type.

Nehring, in his discussion of the Dubois paper in Berlin, December 14, 1895 (Z. Ethn., 1895, Vol. 27, pp. 738-739), views the matter in a different light; he says: "I hold it as very probable that the cranium and the thigh bone, as well as both teeth, belong together"; but it remains uncertain whether the remains may represent a being in direct or a collateral line to man.

Rudolf Virchow, finally, has come to the following conclusions (Z. Ethn., 1895, Vol. 27, several papers; esp. p. 744): "that the skullcap had not belonged to a man, but that much more it shows the greatest resemblances with the skullcap of a Hylobates"; and he is of the opinion that "in accord with all the rules of classification this being [represented by the skullcap] was an animal and that an ape." The teeth appeared to Virchow more ape-like than human. The femur, notwithstanding its resemblance to the human, "shows in its straightness, as in the rounding of its diaphysis, particularly in its lower part, so many agreements with the femur of a gibbon, that

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[1] Turner, Wm., On M. Dubois' description of remains recently found in Java, with remarks on so-called transitional forms between Apes and Man. Journ. Anat. and Phys., Vol. 24, p. 424, 1895.

I find no difficulty in attributing it to a giant gibbon" (pp. 746-747). However (p. 749) regardless of "whether the Pithecanthropus was a transitional form to Man, or an ape, it represents a new member in the line of forms which enable us to see the entire great field of the Vertebrates as an evolutionally connected whole."

SUBSEQUENT HISTORY

By 1897 knowledge of the famous discovery and its discussions had become generalized, without, however, an agreement being reached as to their true meaning. Dubois' contributions to the subject gradually ceased; and the remains themselves became no longer readily accessible; various students, including the writer (1912), failed to obtain permission to see them; even the whereabouts and finally the very existence of the specimens became uncertain and many curious conjectures were raised as to their fate.

The keen interest in the find had, however, by no means died out, and in 1907-1908 it culminated in a new "geological and paleontological" expedition to Trinil by Mme. Selenka, the energetic widow of the well known Munich zoologist of the same name, and Professor Max Blanckenhorn of Berlin. The valuable results of the extensive two seasons' work were published in 1911.[1] No further remains related to the "Pithecanthropus" were discovered. In another locality (near Sondé, a few miles from Trinil) and under circumstances suggesting a possible antiquity, the crown of a human molar was found, "by a trustworthy white man." This tooth was described in the Selenka-Blanckenhorn memoir by Walkhoff (pp. 214-221, pl. XXVIII), who believed it possessed a number of features pointing to a considerable age; but Dubois, on seeing the specimen, pronounced it "a wholly recent and white human lower jaw molar."[2]

The next noteworthy point in the history of the celebrated remains was the posthumous publication of Schwalbe's study of the femur.[3] Schwalbe's conclusion, though old (1899), deserves to be quoted in full. The results are, he says, that the bone "has nothing to do with either the Gibbon or with the remaining anthropoids, and is also readily distinguishable from that of the lower apes, while a difference from the human femur lies *possibly* in the somewhat greater relative length of the diaphysis. At all events the Trinil femur stands so near to the human that on its basis alone the position of the Pithecanthropus would have to be looked for immediately next to that of man." As to the question whether the thigh bone belongs to the skull, Schwalbe, in accord with Nehring, Dames, Jaekel and others, holds as " much more probable that all the parts of the Dubois find belong together, than that they represent different individuals, the femur a man and the skullcap some great ape " (p. 357). As to the nature of the being represented by all the remains, Schwalbe inclines to the Dubois' notion of its intermediary position between the anthropoids and man.

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[1] Selenka, M. Lenore, and Blanckenhorn, Max, Die Pithecanthropus-Schichten auf Java. 258 pp., 22 pls., numerous figs., Leipzig, 1911.

[2] Z. Kgl. niederl. Ges. Erdk.. Vol. 25, Afl. 6, 1908; Selenka and Blanckenhorn's memoir, p. 214.

[3] Schwalbe, G., Studien über das Femur von *Pithecanthropus erectus* Dubois. Z. Morphol. u. Anthrop., Vol. 21, pp. 289-360, 1921. Prepared for publication by Eugen Fischer.

In the summer of 1923 the writer visited Europe in the temporary rôle of a director of the "American School for Prehistoric Studies in Europe." The first visit was to Dr. Smith Woodward at the British Museum of Natural History. Before going over we had had some correspondence in which I expressed my great desire to see the Pithecanthropus originals. These wishes had most kindly been communicated to Dr. Dubois at Amsterdam, and upon my arrival, to my great astonishment and joy, Dr. Smith Woodward handed me a telegram from Dr. Dubois inviting me most courteously to the Teyler Museum in Haarlem, his home town, where he would show me all the originals in his possession. This great privilege was taken full advantage of by me and my class on July 15. It was the first time the precious specimens had been shown to a scientific man after their long seclusion. We found Dr. Dubois a big-bodied and big-hearted man, who received us with a cordial simplicity. He had all the specimens in his possession brought out from the strong boxes in which they are kept, demonstrated them to us personally, and then permitted me to handle them to my satisfaction. Besides the four specimens attributed originally to the Pithecanthropus there was the additional tooth (a premolar), the fragment of the curious fossilized lower jaw, and two interesting, australoid-like, mineralized skeletons from Wadjak. The interior of the skullcap of the Pithecanthropus had now been completely freed from the consolidated tufa that filled it before; a cast of it was made, and revealed a very remarkable brain of an unexpectedly human-like conformation.

The examination of the originals made a deep impression. It was seen that none of the casts of the skull that have been found in different Institutions was wholly faithful, and the same was felt to be true of the previously published illustrations. The originals were seen to be even more important than they had seemed to be hitherto. Dr. Dubois told us he had about finished a final study of the specimens, which was soon to be published.

Later the same summer the specimens were shown also to Professor McGregor, of Columbia University; since then, they have been demonstrated on a number of occasions, including that of the XXI International Congress of Americanists at Hague, 1924, and they have been studied in detail by Hans Weinert.

DR. DUBOIS' LATEST PUBLICATIONS ON THE REMAINS

During that same year (1924), finally, there appeared in the Proceedings of the Academy of Sciences, Amsterdam, three new important publications on the Pithecanthropus remains by Dr. Dubois; the first,[1] on the skull and brain with which the author now definitely associates the fossil mandible, all three teeth and the thigh bone; the second[2] includes 11 excellent plates of the specimens; and the third[3] deals with the femur, and promises for the not far distant future a final exhaustive work on the whole of the remains.

In these latest and ripest communications on the Java remains are found the following statements of special interest:

STATE OF PRESERVATION AND AGE OF THE REMAINS

The bones are in a "state of perfect mineralization" (p. 265). Their specific gravity, like that of the bones of other mammals dug up at Trinil, has risen to about 2.7. They contain only traces of organic matter in the form of humus substances, "which give them a chocolate-brown color." The skullcap "has been greatly corroded on the outer surface by sulphuric acid, formed from pyrites in the volcanic tufa"; the femur (vol. 29, pp. 730-731) appears to be free from such corrosions.

The physical and chemical characters of the bones are such, in Dubois' opinion, that they "stamp the remains of Pithecanthropus as Pliocene" (p. 266); which possibility is further strengthened by the somatological characteristics of the specimens. Dubois, therefore, is still inclined to regard the Pithecanthropus remains as [late] Pliocene rather than Pleistocene.

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[1] Dubois, E., On the Principal Characters of the Cranium and the Brain, the Mandible and the Teeth of *Pithecanthropus erectus*. Proc. Acad. Sci., Amsterdam, Vol. 27, Nos. 3 and 4, pp. 265-278, 1924.

[2] ———, Figures of the Calvarium and Endocranial Cast, a Fragment of the Mandible and three Teeth of *Pithecanthropus erectus*. *Ibid.*, Nos. 5 and 6, pp. 459-464.

[3] ———, On the Principal Characters of the Femur of *Pithecanthropus erectus*. *Ibid.*, Vol. 29, No. 5, pp. 730-743, 1926.

THE SKULLCAP

The skullcap, in Dubois' opinion (not shared by others), "has been deformed in a natural way (through trigonocephalism, though in a small degree)" (p. 266).

Looked at from above, the skullcap is markedly ovoid, with the narrower part in front and extended forward by a large though not very heavy supraorbital shelf which contains large frontal sinuses. This "whole precerebral part of the frontal bone is hylobatoid, like the rest" (p. 267).

The outer surface of the frontal bone shows antero-posteriorly along its middle a slight keel-shaped elevation which terminates above, in about the position of the bregma, in a somewhat more marked rhomboid prominence. Dubois believes this prominence was less marked before the bone was corroded. The median ridge is the so-called median frontal torus and is believed to be due in Man to an early fusion of the two fetal halves of the frontal bone.

Ventrally, the skullcap, particularly in the frontal region, shows strong impressions of the cerebral convolutions. In details of its conformation it agrees partly with man, partly with the gibbon. "The form of the skull of the Pithecanthropus (p. 269) is on the whole not human; nor is it a transition of any type of manlike apes to the human type." The agreement "with the anthropoid cranial type, particularly that of the small gibbon species, of the genus Hylobates, may on the other hand be called perfect"; it extends to many features such as the arching of the vault, the receding forehead, the pre-cerebral part of the frontal bone, the constriction behind the orbits, etc. "In all these points Pithecanthropus is distinguished no less strongly than the Anthropoid Apes from the Neanderthal Man." The detailed characteristics of the skull indicate now to Dubois that the erect posture of the body of the Pithecanthropus, "which clearly appears from the shape of the femur, was not such a perfect one as in Man; the correlation, at least, did not extend to the skull.

"Nor can the skull, however, have belonged to an Anthropoid Ape, because the relatively very large skull as regards shape presents a close, nay striking resemblance with the skull of a small Hylobates species, the smallest of the Anthropoid Apes, whereas judging not only from the femur and the molar teeth, but also from the skull itself, Pithecanthropus must have surpassed the size of a large chimpanzee, and very much that of a middle-sized man" (p. 270).

THE BRAIN

As to the size of the brain, " it may be assumed that with equal body weight Pithecanthropus possessed double the brain quantity of the Anthropoid Apes" (p. 271). The endocranial cast in its side view " presents a striking resemblance with the endocranial cast of a small Hylobates species reproduced at the same size. . . . . There is on the other hand a great difference—and a difference of great importance—between the profile of the endocranial cast and that of the Neanderthal Man of La Chapelle-aux-Saints " (pp. 271-272).

Although the Neanderthal casts, because of their comparatively low height, appear also more simian than the cast of the brain of *Homo sapiens,* both differ markedly from that of the Pithecanthropus in that the parietal region is considerably more developed. Of the cerebral fissures the " most conspicuous, in the front, is, on the right side, the sulcus frontalis inferior, as clear and unmistakable as in any human hemisphere, but in the simplest form, such as it presents shortly before birth" (p. 273). " We meet, therefore, with already perfectly human forms in the frontal cerebral gyri of Pithecanthropus." But in other respects " the brain of Pithecanthropus is not distinguished qualitatively, only quantitatively, from that of the Anthropoid Apes. The double brain quantity (for equal bulk), is the most important characteristic that distinguishes Pithecanthropus from the Anthropoid Apes."

To which Dubois adds (p. 274) : " It seems to me that it is evident, at least, from all this that Man and Pithecanthropus both descend from a common primitive Simian ancestor. From this among the living species, the Hylobatidae, though greatly differentiated by their long arms and sabre-shaped canines, depart least, several fossil Simiidae still less. Also through his mandible and teeth Pithecanthropus deviated less from this common stock type than the three living Gigantanthropoidea and the Hylobatidae."

And p. 178: " The approach of the mandible and the teeth, as also of the femur, to the human type, and the large cranial capacity, added to considerations on the brain-quantities in nearly allied mammalian genera, all this leads me to the conclusion that Pithecanthropus should be considered as a member, but a distinct genus, of the family of the Hominidae."

THE TEETH

No special discussion is given to the three teeth, but their detailed characteristics are noted in connection with their figures.[1] These details as basic data on the teeth are of importance and are therefore given here in full:

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[1] Proc. Acad. Sci. Amsterdam, Vol. 27, Nos. 5-6, 1924.

Anterior left lower premolar. Crown or surface view. Human dimensions and general pattern. On the buccal surface a circle segment-like facet of wear by the upper caninus. On the mesial side an irregular concave facet of contact with the lower caninus. At the summit a strongly developed buccal cusp. No lingual cusp, on its place only confluence of the lingual and connecting transverse rim. The latter dividing the crown surface into a small anterior and a large posterior fossa. A ridge starting from the inner side of the (buccal) cusp descends in the posterior fossa. The same is seen in many anterior lower premolar crowns of anthropoid apes. Distally of (behind) the (buccal) cusp a surface of wear by the anterior upper premolar.

Mesial (anterior) view. Showing the inward bending high buccal, the inward sloping upper and the low lingual side of the crown. Below and before the cusp the irregular facet of contact with the lower caninus. Bipartite lower part of the root, the point of the lingual-distal part broken off.

Distal (posterior) view. Near to lingual side a crescent-like facet of contact with the lower posterior premolar.

Lingual (internal) view. Low lingual crown side. The two fossae. Broadening of the crown upwards. Oblique position of the root (directed backwards).

Buccal (outer) view. Circle segment-like facet of wear by the upper canine. High buccal crownside.

Penultimate left upper molar. Crown or surface view. Surface smoothly worn off. The buccal-distal cusp part small, very much as in many homonymous orang-utan molars. Strongly divergent roots.

Root view. Single lingual root. Buccal root (in this individual) composed of three fused elements, one distal (posterior) and two mesial (anterior) ones.

Mesial (anterior) view. A large semi-ovoid facet of contact with $m.^1$ Buccal and lingual roots strongly divergent, the lingual root departing mostly from the vertical line.

Distal (posterior) view. Ellipse-like facet of contact with $m.^3$

Lingual (internal) view. Direction of the roots backwards.

Buccal (external) view. The root showing the two fused buccal elements.

Last right upper molar. Crown or surface view. Little worn. Moderately wrinkled, much less so than in orang-utan. Semi-ovoid as in some orang-utans, by moderate development of the distal-lingual and excessive reduction of the distal-buccal cusp. The crown as a whole shows reduction. The constriction towards the masticatory surface indicates late piercing of this tooth.

Root view. Of the strongly divergent roots the buccal one of this individual composed of three fused elements, one of which distal and two mesial.

Mesial (anterior) view. Likewise as in Fig. 30 the lingual root mostly departing from the vertical line. No facet of contact with $m,^2$ probably a consequence of the still little use of the tooth on this side.

Distal (posterior) view. Lingual (internal) view. Buccal (external) view. Roots strongly directed backwards, more so than those of $m.^2$

THE FEMUR

The femur is nearly complete and little injured. Some marks of "crocodile teeth" are to be seen at its upper portion. "The large exostosis below the trochanter minor takes the place of the intermuscular connective tissue between the vastus medialis and the adductors. . . . . The resemblance of the fossil femur to that of Man, in contrast to the Apes, is very marked in the knee-joint, which was adapted for perfect extension of the leg. . . . . In the röntgenogram, both in that of the upper end of the femur and the lower end, the "trajectoria" of the human type may be recognized, though on account of the filled cavities they are not so clear as in other thigh-bones.

"Two characters distinguish the Trinil femur very decidedly from that of Man. These are in physiological relation to each other, though the first refers to the form of the lower part of the diaphysis and the other to that of the trochanter major at the superior extremity of the femur. Down to low on the popliteal surface and beginning at more than 11 cm. above the level of the patellar articular surface the back side shows a median swelling and rounding." In no human femur described or known to the author does this convexity rise in the same degree or does it bulge upwards to such a buttress-like median swelling as in the Pithecanthropus.

In the "cross-sections of the fossil femur the complete absence of an angulus medialis also strikes the eye, in contrast with the human femur, but in accordance with this bone in Apes. In Man the inner side (as *angulus medialis*) remains free from attachment of muscles; in the Apes, on the other hand, the origin of the vastus intermedius or of the vastus medialis continues on the inner side of the femur, enveloping this bone continuously. Thus it seems also to have been in Pithecanthropus."

The peculiar shape of the lowest third of the femur is attributable, according to Dr. Dubois, to static and mechanical causes and hence modified muscle attachments, in the lower limb of the Pithecanthropus.

The second special character "that very definitely distinguishes the femur of Pithecanthropus from that of Man, and which is in physiological relation to the just described character, is the position of the trochanter major in the continuation of the diaphysis. . . . . The posterior border with the whole great trochanter is directed vertically upward. In Man, on the other hand, as well as in almost all Apes, Monkeys and Baboons the posterior border with the whole great trochanter has an oblique direction upwards and forward (fig. 32, femur of a Dutchman). In Pithecanthropus the great trochanter is not placed on the diaphysis slanting forward as in Man and in the whole Monkey tribe, with the exception of two genera, but forms as it were, a prolongation of the diaphysis upwards. This points to a peculiar condition of the musculus glutaeus medius (and the m. gl. minimus) in Pithecanthropus."

Judging from the characteristics of the upper portion of the femur, the Pithecanthropus in Dr. Dubois' opinion "cannot have possessed a human-shaped pelvis, but as the femur could to all appearance be extended to a human degree, the pelvis may have been comparatively more human than that of Hylobates and Chimpanzee. The tendon of the glutaeus medius was inserted more posteriorly of the center of rotation of the hip-joint, and produced, therefore, a stronger outward rotation constantly accompanying the abduction. With fixed leg the strong muscle brought the center of gravity of the body from the other side above that leg, and turned the front of the trunk to the other side. With such an unhuman pelvis the locomotion of Pithecanthropus cannot have been exclusively, perhaps not even chiefly, on the ground. The erect type was not perfectly developed."

The characteristics of the hip-joint and also the knee-joint "render it probable that Pithecanthropus was less ground-walker than tree-climber, but did not climb with a prehensile foot, in the way of Apes. . . . . The femur of Pithecanthropus was, therefore, also fit for locomotion on the ground, but by no means adapted so exclusively for it as in *Homo sapiens* and *Homo neandertalensis*."

MEASUREMENTS

In his 1924 publications on the Pithecanthropus skullcap and femur Dr. Dubois gives a series of measurements which doubtless are his latest taken on the originals and are therefore of considerable importance. The principal ones are as follows:

LATEST MEASUREMENTS OF THE TRINIL SKULL BY DUBOIS

Length max., deduced		18.4 cm.
Length max., as obtained on the damaged specimen		18.05
Breadth max.		13.1
Cranial index	*71.2*	
Calvarial height (height max. above the glabella-inion line)		6.1
Diam. frontal min., now		(8.7)
Diam. frontal min., undamaged, was probably		9.1
External orbital facial breadth, estimated		11.5
Fronto-biorbital index (percental relation last two diams.)	approx. *79.*	
Nearest approach of temporal lines, probably		8.5
Sagittal arc-length:		
Frontal part		10.0
Parietal		9.0
Occipital, upper part		4.5

Fronto-parietal index	*90.*
Endocranial:	
Length max.	r. 15.5 cm. l. 15.3
Breadth max.	12.4
Index	*80.*
Height max. (above the line of max. transverse diam.)	5.8
Cranial capacity, present conclusion, approx	900 cc.

LATEST MEASUREMENTS (AND PRINCIPAL NOTES) ON THE FEMUR

(Dubois)[1]

Weight of the bone	1,018 grams

(This is more than twice the weight of a similar nonfossilized human femur of same size.)

Volume of the bone	485 cc.
Volume of the bone without exostosis, nearly	467 cc.

(On an average, negroes and also Australians have a slightly less voluminous femur, at the same length; in Europeans, on the other hand, it is on the average much more voluminous.)

Length, bicondylar	45.5 cm.
At middle:	
Antero-post. diam.	2.9 cm.
Transverse diam.	2.8 cm.
Circumference	8.9 cm.
The head:	
Transverse diam.	4.47 cm.
Sagittal diam. (perpendicular to preceding)	4.40 cm.
Curvature of the diaphysis	8 mm.

(In comparison with most human femora this curvature is slight, the summit of the curve low.)

Angle of torsion	19°
Angle of neck with shaft	123°

The pressure-axis in man passes through the external condyle; in the Trinil femur it falls between the condyles.

The convexity of the posterior surface of the lower end of the Trinil femur exceeds that in any human femur known or described.

GEOLOGICAL AGE OF THE TRINIL DEPOSITS

As to the geological age of the deposits from which the Pithecanthropus remains were recovered, Dubois at first (1895) was uncertain whether to attribute them to the latest Pliocene or early Pleistocene, but later (1896) was inclined to regard them as Pliocene.

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[1] Dubois, E., On the Principal Characters of the Femur of *Pithecanthropus erectus*. Proc. Acad. Sci. Amsterdam, Vol. 29, No. 5, pp. 730-743, 33 figs., 1926.

The latter view was, according to Schuster, supported by Stremme;[1] for K. and Frau Martin and Elbert[2] the deposits were old Quaternary; for Pohlig,[3] Volz[4] and Carthaus[1] mid-Quaternary. Julius Schuster,[5] on the basis of his study of the plant remains secured by the Selenka 1907-08 Expedition to Trinil, from the Pithecanthropus deposits, reached the conclusion that they date from the time when Java [and Sumatra] was still connected with the Asiatic mainland; that this connection was severed in the old diluvial [early Quaternary] times; and that the flora of the Pithecanthropus layer, and necessarily also the remains of the latter, could be neither more recent nor older than the old diluvium [early Quaternary], and that the nature of the flora speaks for a cooler and moister period.[4] In his more extended report in the Selenka-Blanckenhorn Memoir[1] Schuster believed that he had demonstrated that "the *Pithecanthropus erectus* lived in the Old-Diluvium [early Quaternary] and that during the large Pluvial period." Blanckenhorn[1] (p. 268), after critically reviewing the whole evidence, decided also for the Great Rainy period, or, more definitely, for the first (Günz-Mindel) interglacial.

CRITICAL CONSIDERATIONS

The remains ascribed to the "Pithecanthropus" have, as indicated in the preceding pages, given rise to a great deal of scientific speculation and contention, which to this day has led to no definite, stabilized result. What are the causes of this unsatisfactory condition?

The causes are multiple; they relate to everything from the circumstances of the find to the identification of the remains. But viewed with due perspective they reduce to two main difficulties that will be met with again and again in the studies of early man and related forms. The first of these is the inadequacy of the Java material; and the second is the lack of sufficient materials for decisive comparisons.

Defects of the material.—The Trinil remains occur in secondary deposits; the initial data on them are perhaps not as detailed as desirable;

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[1] In Selenka, M. Lenore, and Blanckenhorn, Max, Die Pithecanthropus Schichten auf Java, Leipzig, 1911; with the collaboration of E. Carthaus, C. M. Dozy, K. and H. Martin, H. Stremme, H. Pohlig, Walkhoff, D. Schuster, and others.

[2] Ueber das Alter der Kendeng-Schichten mit *Pithecanthropus*. Neu. Jahrb. f. Min., Beil., Vol. 25, pp. 648-662, 1908.

[3] Eiszeit und Urgeschichte des Menschen, p. 88, 1907.

[4] Gaea, Vol. 45, p. 385 *et seq.*, 1909.

[5] Schuster, J., Ein Beitrag zur Pithecanthropus-Frage. Sitzber. K. Bayer. A. K. Wiss., Abh. 17, 30 pp., 1909. Munich, 1910.

they were not found sufficiently close together, especially in the case of the femur, to remove all doubt as to their belonging to the same individual or even the same form; the skull shows considerable loss of parts as well as substance, conditions not present in the femur; while morphologically there seems to be some disharmony between the different specimens, so that their ready acceptance as representatives of one form and one individual is initially rather difficult.

As to the localization of the specimens, it is not easy to conceive how the skull and a femur of the same individual, in any, but especially in secondary deposits—if the Trinil deposits are such—could come to lie 50 feet from each other; though such an occurrence cannot be said to be impossible even in secondary accumulations. Here is the first weakness in the case.

The skull had certainly suffered much damage before its final inclusion. Though evidently proceeding from an elderly individual where many of the sutures are closed and all the parts are resistant, it nevertheless has lost the whole face and especially the whole base. This may mean a rot, or mechanical damage, or both. None of this, we know amply from experience, is inconsistent with the status of the skullcap as found; it is also true that such a strong bone as the femur may persist almost intact, especially on the surface of the ground, though the skull and most other parts of the skeleton may have been more or less destroyed. Nevertheless finding two specimens well apart and in such different states of preservation, cannot but raise a question as to their belonging to the same individual. This is the second weakness of the find.

The morphological details of the several parts offer a number of difficulties.

The skull shows obliteration of all the sutures of the vault, which indicates an elderly individual. In such elderly primitive beings, whether human or anthropoid, the teeth are generally more or less worn; but of the three teeth associated with this Trinil cranium the anterior left lower premolar shows practically no wear, the last right upper molar is little worn, while the penultimate left upper molar shows a surface that is smoothly worn off (Dubois, Proc. Acad. Sci. Amsterdam, 1924, Nos. 5 and 6, pp. 463-464, pls. IX-XI). These conditions are inconsistent with the notion that all these teeth and the skull belong together. Here is another incongruity and hence weakness; but there are others.

The skullcap indicates plainly enough a female individual, as well recognized by Dubois and not effectively contradicted by other students. The length of the femur, however, corresponds to a stature of at least 165 cm. This would agree with about the medium human stature in a male, but is far above that of the female, the average human female height except in a few of the tallest human groups approximating 153 cm. It would further mean that the corresponding male Pithecanthropus had a stature of about 177 cm. (nearly 5 ft. 10 in.) or over. All of which is possible, or may have been modified through a different relation in the Pithecanthropus of the length of the femur to that of the body. Nevertheless the matter constitutes another aspect of the case on which more light is needed.

All of this, and there are other points, cannot but leave the association of the several parts found at Trinil, however probable this may appear, in some uncertainty; which is further increased by the late definite attachment to the Trinil remains of the Brubus jaw.

But all this is not the pivotal essential of the find, and diminishes in no wise its high interest and value, both of which are universally acknowledged, particularly since the endocranial cast has become available. Neither should the student allow himself to be confused by the seeming flood of discrepancies of opinion on the remains. The differences are often more apparent than real, and even where real they by no means discredit the find, but are only so many attempts, under all the great limitations of our present collections and knowledge, to reach a true conclusion.

The Trinil skull alone is sufficient to establish the presence in what is now Java, somewhere during the early Quaternary and possibly earlier, of a class of beings that so resembled the anthropoid apes, on one hand, and came so far in the direction of man on the other, that if they were to be named today we could hardly find a more appropriate name for them than "Pithecanthropus."

Broadly speaking, it is really of little moment whether one student calls these beings giant gibbons, another human precursors, or intermediary forms, and a third a *proto-homo,* or even a very low man; unless they have strayed from the truth through a lack of sufficient contact with the remains, they all mean a form somewhere between the status of all the known apes and all except perhaps the earliest man. Who can say just where we could class a being with such an ape-like skullcap, but with such a near-human brain within it, if he appeared in life today? Witness the conclusions of the able discoverer himself, who has had the originals at hand now for 36 years; first they represent for him a great chimpanzee, then a human precursor and direct ancestor, and then an intermediary but not human ancestral form.

The brain form of the "Pithecanthropus," which, because of the filling of the skull cavity with a hard mass, did not become observable until three years ago, is exceedingly important (pl. 7). Its size and form and gyration appear to remove it at once from the brains of all known apes and bring it correspondingly closer to that of man. It is inconsistent with and morphologically superior to its own skull. The brain cavity measured in capacity at least 900 cc. and this for a female. A corresponding male brain cavity would measure somewhere about 1,100 cc. These dimensions connect already with the human. In the writer's collections, in the U. S. National Museum, there are 32 American Indian skulls, of small statured but otherwise apparently normal individuals, ranging in capacity from 910 to 1,020 cc. In the hugest gorilla this capacity does not exceed, so far as known, and mostly is well below, 600 cc.; and in the chimpanzee or orang it never reaches even this size. The frontal lobes of the Java specimen, while still low, approach in their form the human, lacking the pointed, keel-shaped appearance they have in all the apes; and the rest of the brain was of a higher type than that of the apes. Had this form advanced in its brain size and form by again as much as it already stood above that of the known apes, it would be wholly impossible to exclude it from the human category, unless it was done by the establishment of a separate genus of creatures, equivalent in brain mass and brain differentiation to *Homo*.

With all this it could not be legitimate to assert that the Pithecanthropus was either a form of early man or one that eventually evolved into man. Either of these conclusions would demand decisive supporting material, which does not exist. The most that appears justifiable, until further and conclusive evidence appears, is to regard the Pithecanthropus, as represented by the skullcap, to have been a high Primate of as yet uncertain ancestry and no known progeny, far advanced in what may be termed a humanoid direction.

As to the teeth and femur, they must remain more or less problematical until further discoveries. They are not absolutely needed by the Pithecanthropus for his establishment, though they, particularly the femur, would, if definitely identified with the skullcap, enlighten us on points of importance. The two molars, with much probability, belong to the skull; the premolar, the femur and especially the lower jaw, are much more doubtful. There is some legitimate doubt whether individually or collectively they belong even to the same form of beings. But if not, then the problem, instead of being simplified, becomes much more complex, for we are then confronted with the question as to what were the additional creatures represented by these specimens.

All of which points most insistently to the great need as well as promise of much further paleontological explorations in Java and the far southeast in general.

THE WRITER'S VISIT TO TRINIL

Before the 1924 publications by Dubois were received, the writer was enabled to make a visit to Java, the main object of which was to see personally the conditions at the site of the Pithecanthropus.[1] The object was not to excavate, which for various reasons would hardly have been feasible, but to obtain that invaluable impression which comes only from personal examination. The colonial authorities and in particular the scientific men of Java gave all possible assistance, for which once more the writer wishes to tender them a grateful acknowledgment. Preliminary inquiries resulted in the information that there was then no vertebrate paleontologist nor any student of prehistory on the island, that no systematic work was being done in these lines, and that the collections in the local museums and institutions contained little if any human or primate material. Since the Selenka Expedition no further work has been done at Trinil.

On May 24, the writer left Bandoeng, and after a highly interesting 11-hour trip through the central parts of Java, arrived at Madioen, a good-sized town and the seat of a Residency of the district to which Trinil belongs. The same evening arrangements were made with the Assistant Resident, Mr. J. T. H. Jarman, at Ngawi for the visit to Trinil, and early next morning the start was made in a motor car and over a good road to Ngawi, 21 km. (13 miles) distant. At Ngawi, Mr. Jarman met us with his Chief of Police and two motor bicycles with side cars; and in a short time the party was on its way to Trinil, 15 km. (nearly 9½ m.) distant.

We stopped at a plantation, a short distance from the river; and as a pleasant surprise arranged by Mr. Jarman there came in a few minutes several natives, each carrying a basket with a lot of black objects in it—fossil bones from the Pithecanthropus site. These were eagerly examined on the spot—but regrettably there was no trace of any Pithecanthropus.

A few minutes' walk brought us to the elevated right bank of the Bengawan or, in the native pronunciation, Banáwan river. A little to the right was seen a concrete monument, three feet high, with the inscription: P. e.—175 M., with an arrow pointing towards the spot on the opposite shore where the remains were discovered; and underneath was the date 1891/93. This monument was erected here by Dubois both to commemorate the find and to fix the point where it was made. Regrettably the concrete is beginning to crumble, so that already the valuable landmark needs restoration.

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[1] For preliminary account of the voyage, see Explorations and Field-Work of the Smithsonian Institution in 1925, Smithsonian Misc. Coll., Vol. 78, No. 1, pp. 69-72, 4 figs., 1926.

From this point, at the time of low water, the river ranges from approximately 75 to 200 feet in breadth. The water is sluggish and greenish mud-gray in color, with muddy flats exposed at the edges as if after a tide. The Pithecanthropus site appears as a low ledge covered with what looks like rocks, dark grayish brown in color. The river shows no very deep erosion, and the crumbling banks are mostly steep. Cultivated land extends on both sides and there is no jungle, though parts of the shore are covered with wild growth. The river meanders through what appears to be a shallow depression, on a plain, between the great Lawu volcano to the south and a distant low ridge to the north.

Outside of the monument there were no traces remaining of either Dubois' or Selenka's excavations, and only one old man in our party knew the sites.

By this time a dozen or more native men and boys had congregated on the elevated bank opposite the site of the Pithecanthropus, squatting on the ground, and before each was a little pile of specimens—more fossil bones from the site of the Pithecanthropus. Some of these fossil bones were said to have been picked up on the site since the night before. A number of nice specimens were sold by the natives for a mere pittance, but again no trace of anything even suggesting a primate. Several of the boys, as soon as they disposed of what they had, shed the little clothing they had on, and naked, waded and swam across the river to look for some more, but found only a few slivers. When the writer was ferried over, nothing of any value was left.

On closer examination the terrain is seen to rise from the river in this vicinity to two platforms of different heights, the lower on the right side of the river being about 20 feet above the present level of the water. Further down the river, as seen later, the banks are of rather uniform height, ranging to about 20 feet above the level of the water at that time. They show stratified sands and fine gravel, but the stratification is not uniform or always horizontal. Here and there are seen strata of coarse and more consolidated gravels or lapilli, and beneath this once in a while appear dark blackish-blue patches resembling that at the Pithecanthropus site. On closer examination most of these dark lower deposits are seen to consist of gravel, or lapilli, sand and mud, with what was seemingly originally volcanic ashes.

The Pithecanthropus level had evidently just been exposed by the receding water. It was found covered with irregular small " ledges " and different sized " rocks," some more solid, yellowish, sandstone-like, others dark in color, consisting of gravel, sand and mud, and not very solid, being quite easily broken by a harder stone and then crumbling in the fingers.

The stratification of the bank at this site was obscured, but its main features were known from a chart prepared by the Selenka Expedition in 1910. The site itself is not large and a few hours of examination gave about all that could be had without excavation. A native boat was then engaged and in this the writer made first a little trip upstream, and then proceeded slowly down the Bengawan examining the banks on both sides wherever they seemed to offer anything of interest, down to Ngawi, which was reached that evening. This is a wholly native river, and many interesting sights were seen during our passage.

Before leaving for Madioen that night the writer tried to impress upon the very kind Assistant Resident the need of watching the site of the Pithecanthropus and collecting each year, with the help of the natives, everything that the water may wash out. I left with the sad feeling that science was neglecting one of the most important sites and regions in the realm of investigation. The whole river should certainly be thoroughly surveyed and watched. A simple order of the colonial authorities would at least effect, with a very small expense if any, the saving each year of whatever the river may wash out,[1] among which at any time there may appear specimens of much importance. But what is needed is a prolonged excavation under constant scientific supervision; excavation which here could be carried on at a relatively small expense, because of the cheapness of labor.

The bones obtained by the writer from Trinil are in an excellent state of preservation. They are brown to black in color and fully mineralized. Those that the writer had the good fortune to see and collect showed a number of interesting conditions. The first was that the specimens were all fragments, except in the case of smaller bones or individual teeth. The second was that the fragments as a rule were considerably water-worn of old, and that many of the specimens appeared water polished. And there was a great mixture of forms. All of which indicates, it seems, secondary deposition, in other words deposition of bones that already have been dissociated, carried, and washed more or less by the stream. Judging from this as well as from the results of the Dubois and Selenka excavations, it would seem that the fossiliferous deposits at Trinil would have to be regarded as essentially secondary deposits; though this would not have made an occasional inclusion of whole parts or even whole bodies impossible.

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[1] That fossil bones are washed out from the deposits each year, left on the ledges and collected by the natives who dispose of them for very small compensation to whoever is interested in them, has been attested to the writer by all with whom he came in contact, from the Assistant Resident to the natives; and not the slightest traces of any excavation by any one was seen. If there is any excavation by the natives, as Professor Dubois seems to believe, it surely was not apparent.

THE LATEST CONTRIBUTION TO THE STUDY OF THE REMAINS

While the writer was completing the above, a new publication on the Pithecanthropus came to hand in the form of an extended memoir on the remains by Dr. Hans Weinert, of Munich.[1] The author, to whom we owe the final restoration and description of the skull of the *Homo mousteriensis* youth, has been given the opportunity by Dubois of studying the original specimens, more particularly the skullcap and the teeth, and of taking very detailed measurements, which he now makes available.

For the many details of Dr. Weinert's work, it will be necessary to consult the original. The main conclusions may, however, be summarized as follows:

Much of the problem relating to the Pithecanthropus the author regards for the present, and before any new finds are forthcoming, as unsolvable. He is inclined to separate the lower jaw from the consideration of the rest of the specimens. It is quite possible that it may have belonged to the form Pithecanthropus but a decisive conclusion on this point is not possible.

As to the six Trinil specimens, the conclusion as to whether they all belonged to the same individual or form, also remains still open. As to the skullcap, this assumes morphologically a stem between the chimpanzee and the Neanderthal Man, and in such a way that it inclines nearer to the human side. As to the question whether the morphological sequence may also be extended to a phylogenetic one it may only be said (pp. 541-542) that the Trinil skullcap shows nothing that would make such a sequence impossible. " But with the recognition of the Trinil skullcap as a transitional form [to man] it is naturally by no means said that precisely from *this* Pithecanthropus recent men have been developed." It is more probable that the descendants of the Trinil Pithecanthropus have not reached the present time. Notwithstanding this, the Pithecanthropus phylogenetically is nevertheless to be regarded as a connecting form; for he is a paleontological proof that such transitional beings really existed. Whether precisely the Javanese Pithecanthropus is a direct member of our genealogy, is somewhat secondary, and we must regard as overdrawn all theories which would base on him the conclusion that man originated in southeastern Asia. " The chimpansoid juvenile skull of Taungs, together with the corresponding lower jaw of Piltdown in southern England show us in connection with the Trinil remains of Java what space for the cradle of man is available. On the points of this triangle, which embraces almost all the Old World, we have fossil representatives of chimpansoid derivation, which were all suitable with a corresponding further evolution to reach the stem of the *Hominidae*. . . . . But a single discovered fossil specimen can never seriously serve as a proof for the origin of a whole genus" (p. 542).

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[1] Weinert, Hans, *Pithecanthropus erectus.* Z. Anat. u. Entwicklungsgesch., Vol. 87, pp. 522-524, 1 fig., 1928.

The exact age of the remains is still somewhat uncertain.

Concerning the question whether the femur and the skullcap belong to the same individual nothing decisive has as yet been brought forth, though such connection seems most probable. The placing of the Trinil femur between our anthropoid ancestors and the Neanderthaloid forms of man appears not impossible.

Taking everything into consideration the indications are that the *Pithecanthropus erectus* was a being that well deserved the name of " a human transitional form from Java" which, not in single specimens but as a type, can show us the way followed in human evolution from the lower forms.

" Just as the next lower relations of this form were still animals, while the next higher relation was undoubtedly man, so may the Pithecanthropus be the ' missing link ' that Dubois was searching for and found. Should it be necessary, however, to substantiate the appurtenance of this intermediary form to one or the other side then it belongs undoubtedly to that of the human kind. The *Pithecanthropus erectus* is a *Homo* whose unique position and its undisputed significance justify the generic name of 'Ape Man ' " (pp. 545-546).

The following gives an abstract of Dr. Weinert's measurements of the skullcap, contrasted with those of Dubois.

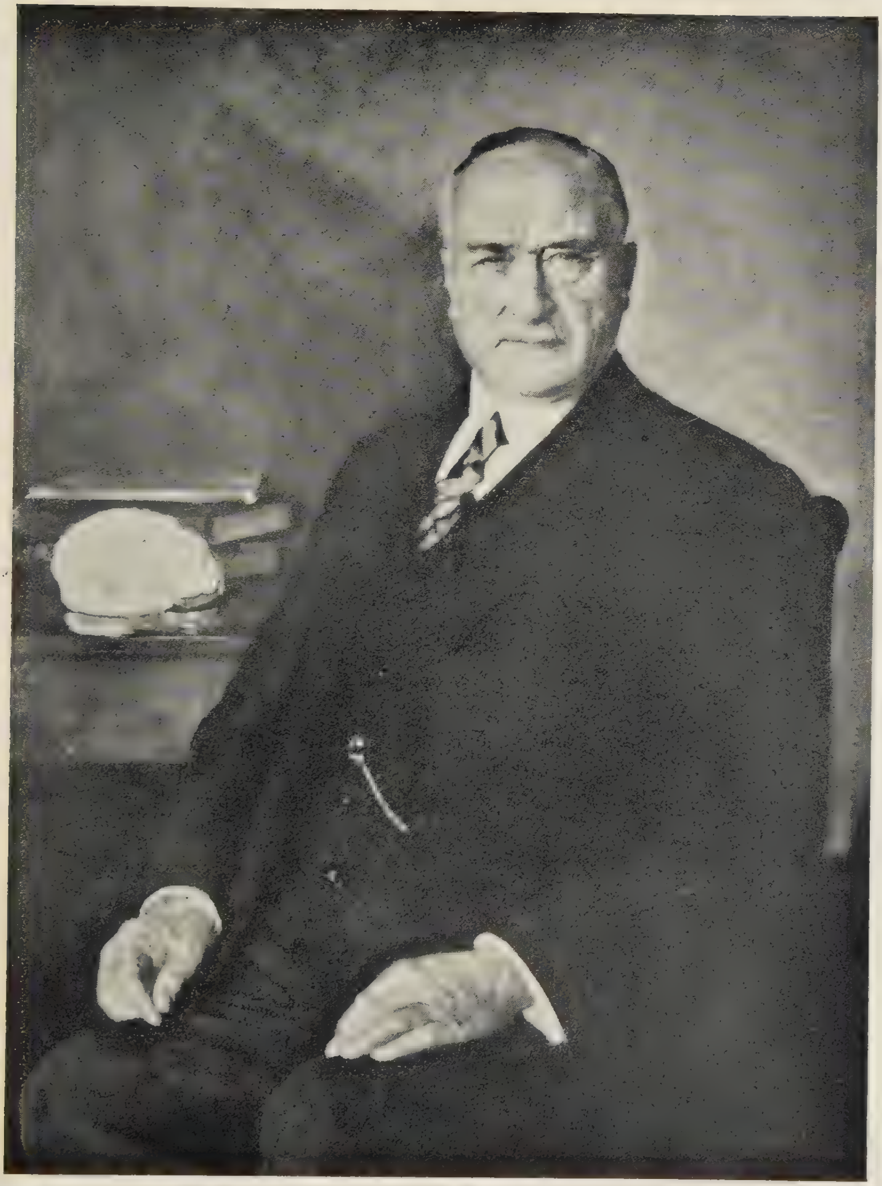
DUBOIS' AND WEINERT'S MEASUREMENTS OF THE PITHECANTHROPUS SKULLCAP

	Dubois (1924)	Wienert [1] (1928)
Length max., deduced	18.4 cm.	18.3 cm.
Length max., as obtained on the damaged specimen	18.05	18.05
Length, from ophryon	....	17.0
Breadth	13.1	13.0
Cranial index	*71.2*	*71.04*
Calvarial height (height max. above the glabella-inion line)	6.1	6.1
Basion-bregma height, estimated	....	10.5
Diam. frontal min., now	(8.7)	8.5
Diam. frontal min., undamaged was probably	9.1	....
External orbital facial breadth, estimated	11.5	....
Fronto-biorbital index (percental relation last two diams.) approx	*79.0*	
Nearest approach of temporal lines, probably	8.5	....
Sagittal arc-length:		
Frontal part	10.0	10.0
Parietal	9.0	9.1
Occipital, upper part	4.5	4.6
Occipital, whole, estimated	....	10.3
Fronto-parietal index	*90.0*	....
Endocranial length max.:	R. 15.5	15.4
	L. 15.3	15.3
Breadth max.	12.4	12.5
Index	*80.0*	*81.17*
Height max. (above the line of max. transverse diam.)	5.8	5.7
Height (total, ob-ba), estimated	....	10.0
Cranial capacity, present conclusion, approx.	900 cc.	1,000 cc.
Brain weight, approx	....	870-920 gm.

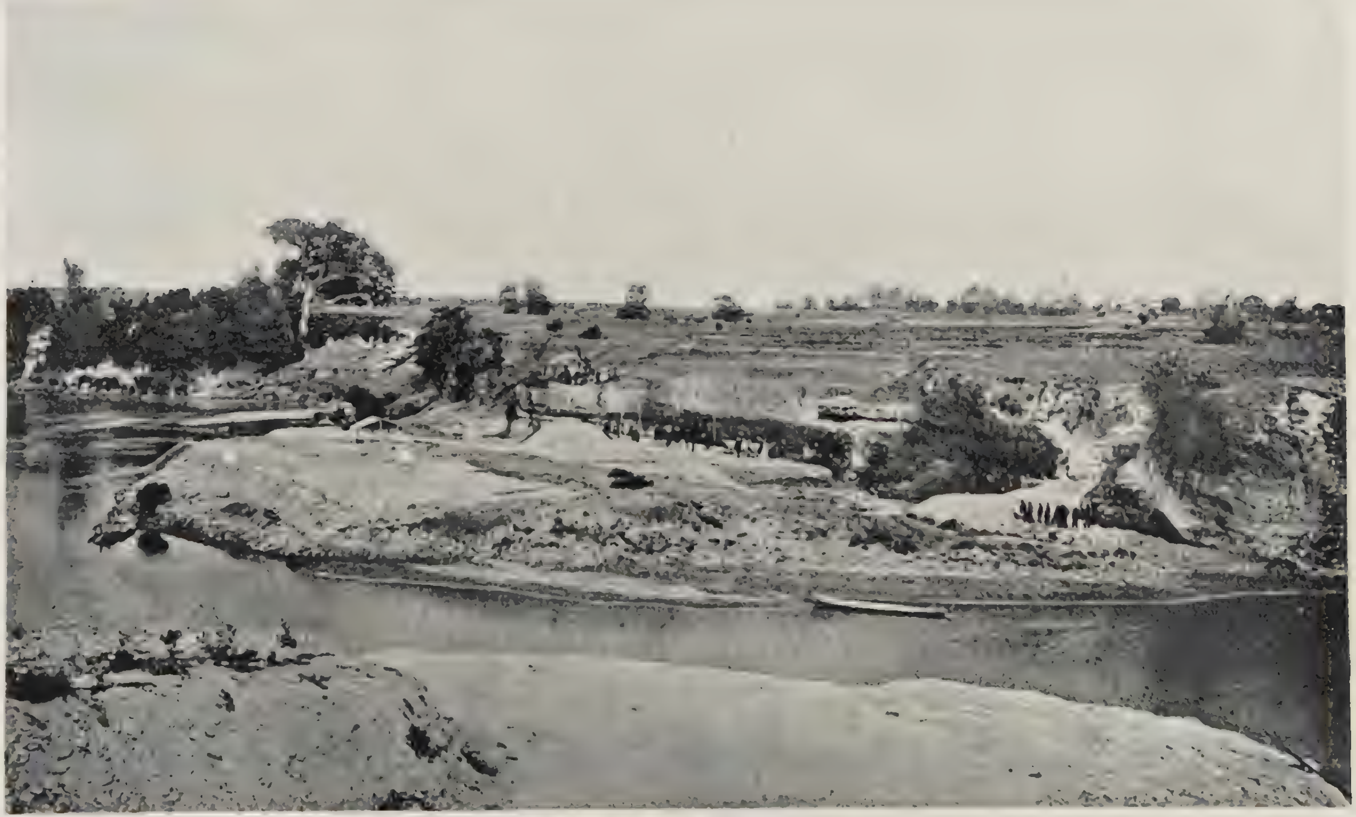
[1] Many additional measurements are given by Weinert, *loc. cit.*, pp. 485 *et seq.*

THE "SECOND PITHECANTHROPUS"

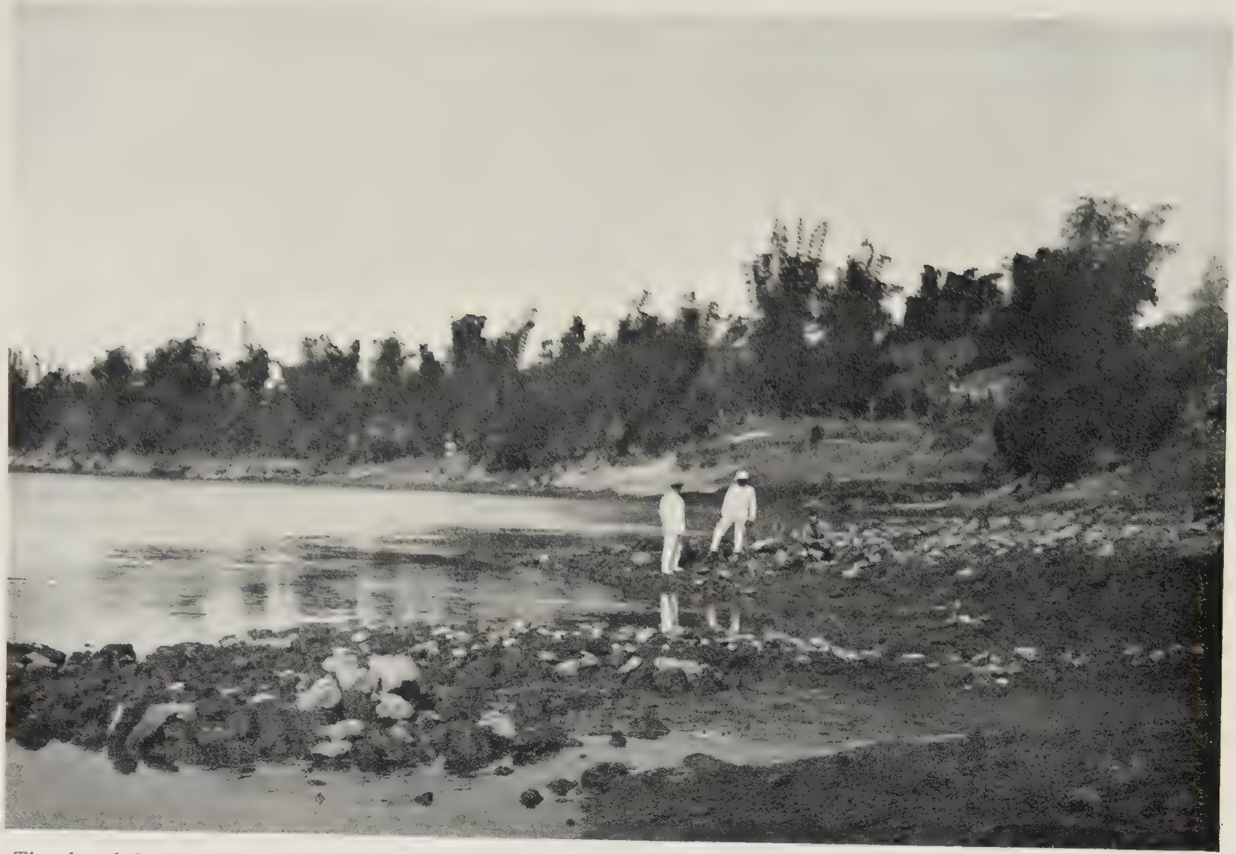
While in Soerabaia, in 1925, the writer gave a lecture at which he called attention to the present conditions at Trinil. Attending the lecture among others was Dr. Heberlein, a Government physician. In September of the following year the Associated Press announced



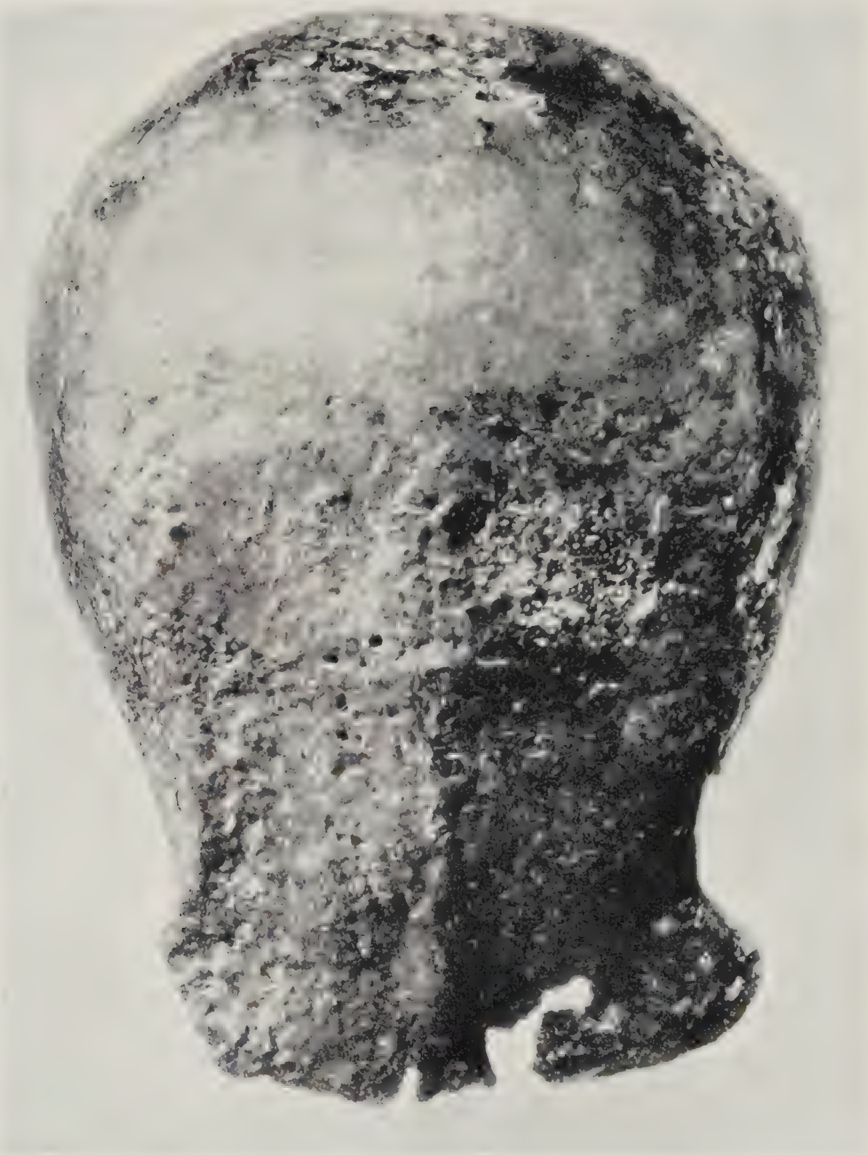
Dr. Eugène Dubois.



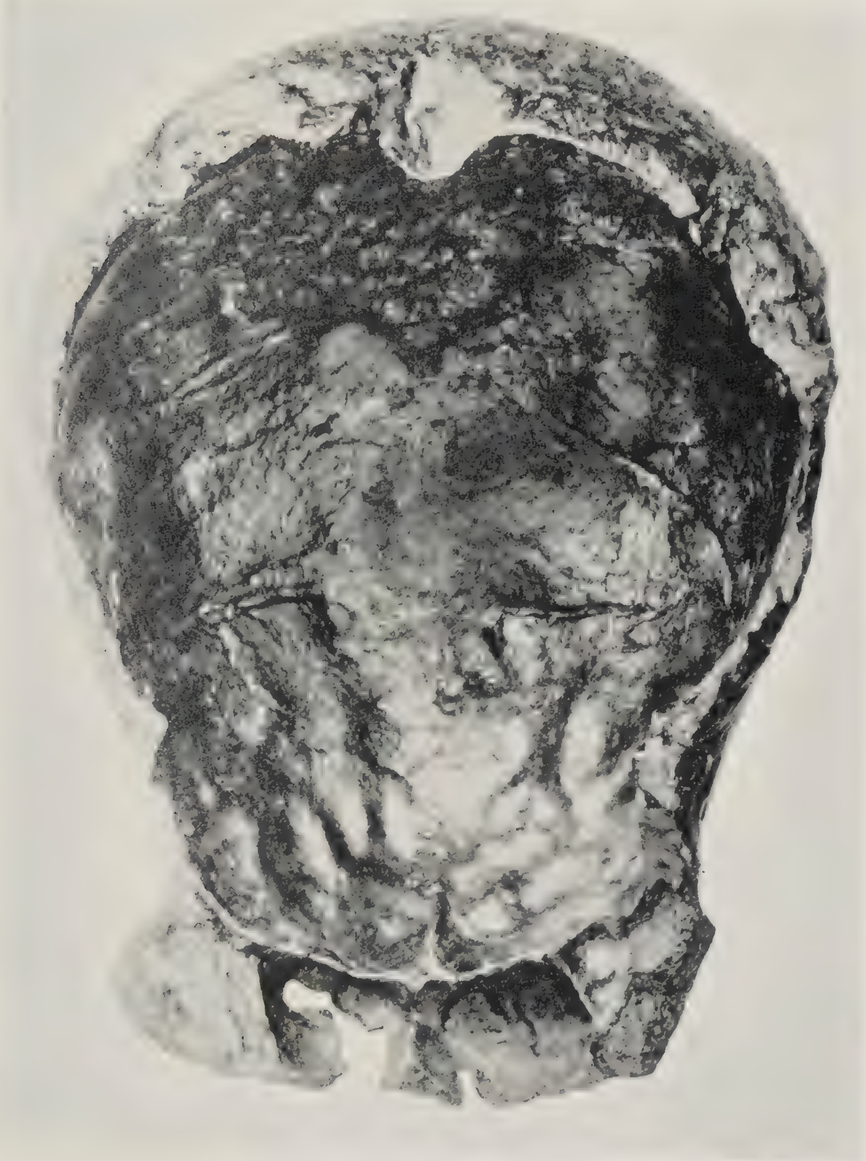
The locality of the Pithecanthropus find, on the Bengawan river, near Trinil, Java. The two white squares show where the femur (left) and the skullcap (right) were discovered. (After Mme. Selenka and M. Blankenhorn.)



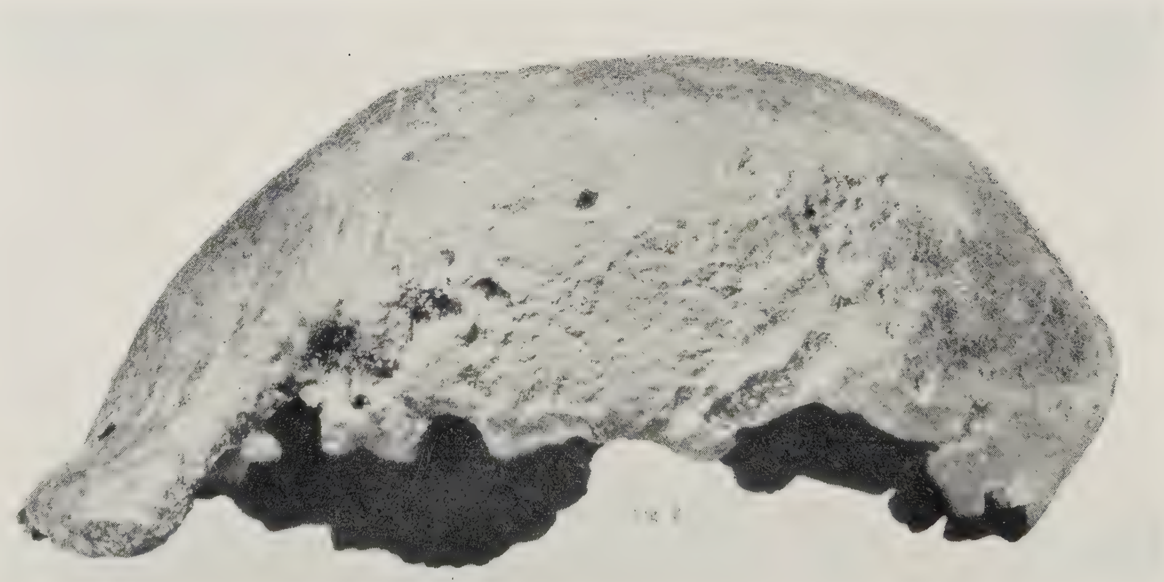
The site of the Pithecanthropus, summer, 1925. (Photographed for Hrdlička by the Assistant Resident, J. T. H. Jarman.)



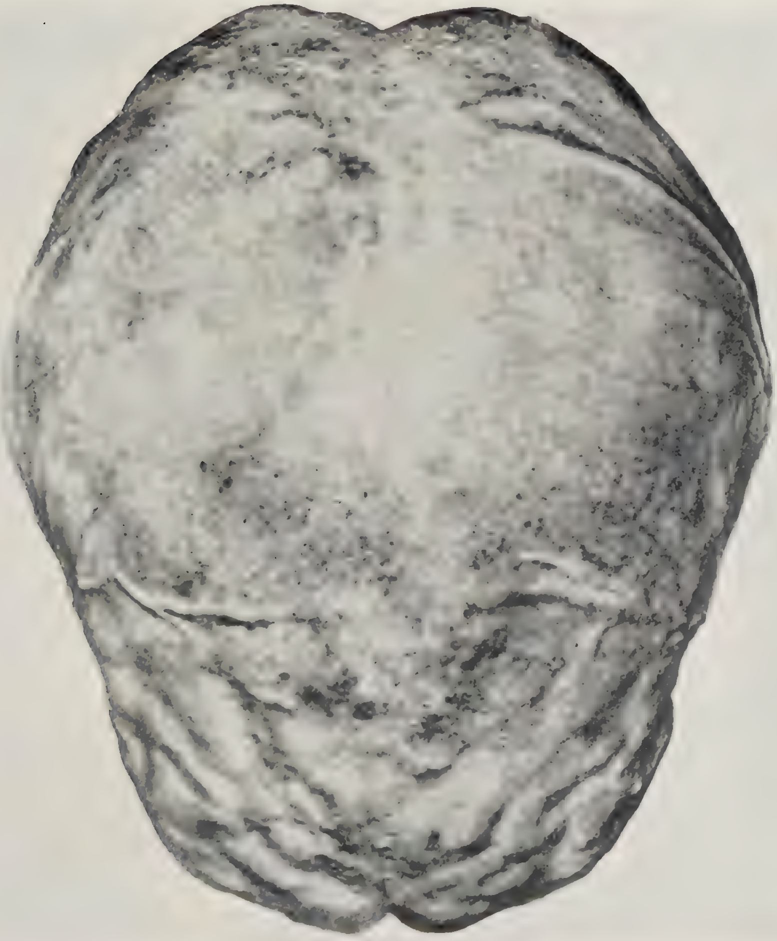
The skull of the Pithecanthropus, top view. (After Dubois, Proc. Acad. Sci. Amst., 1924.)



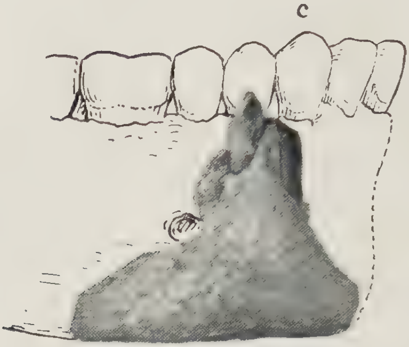
The skull of the Pithecanthropus from below. (After Dubois, 1924.)



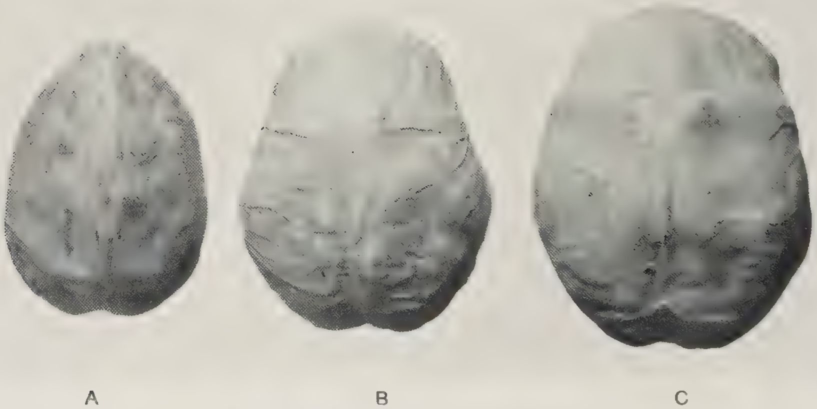
The Pithecanthropus skull, side view. (After Dubois, 1924.)



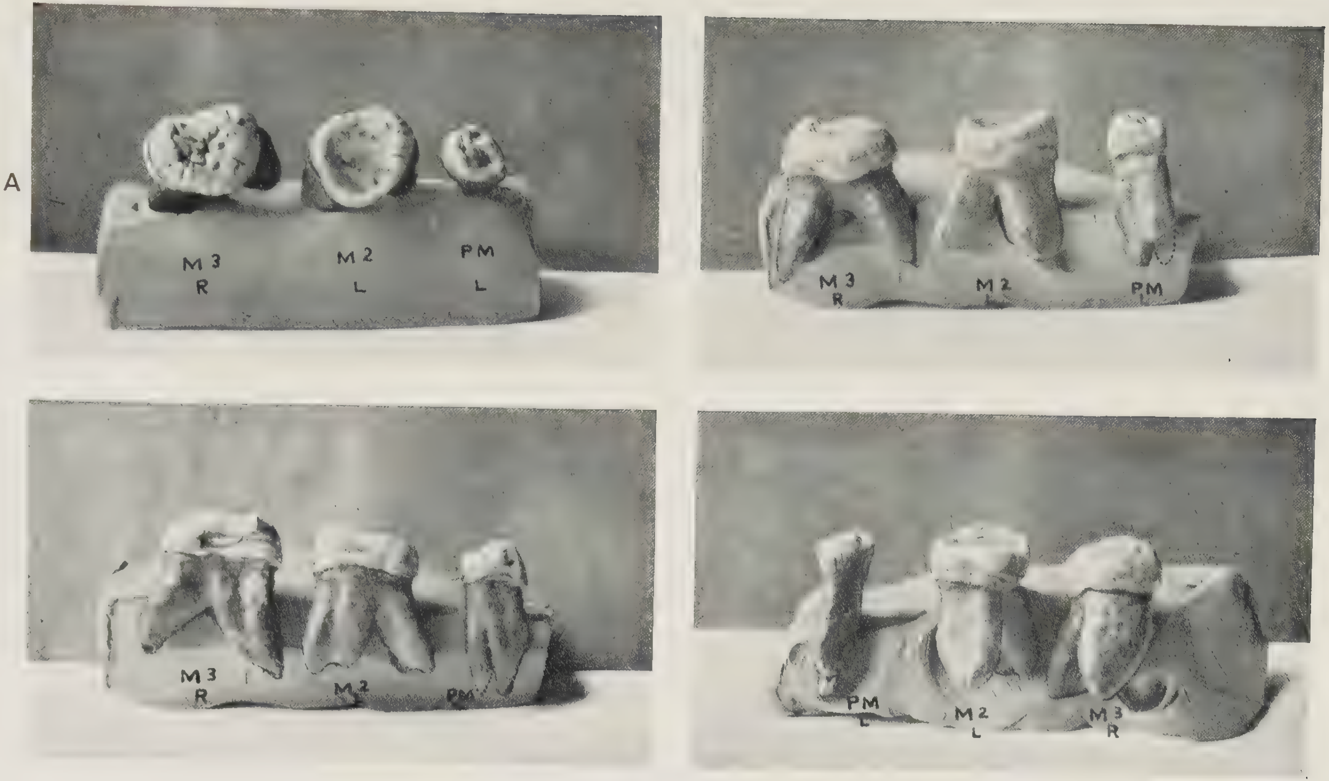
The endocranial cast of the Pithecanthropus. (After Dubois, 1924.)



1. Mandibular fragment from Kedung Brobus.



2. Pithecanthropus brain. (After McGregor.)


A
M 3
R
M 2
L
PM
L
M 3
R
M 2
L
PM
M 3
R
M 2
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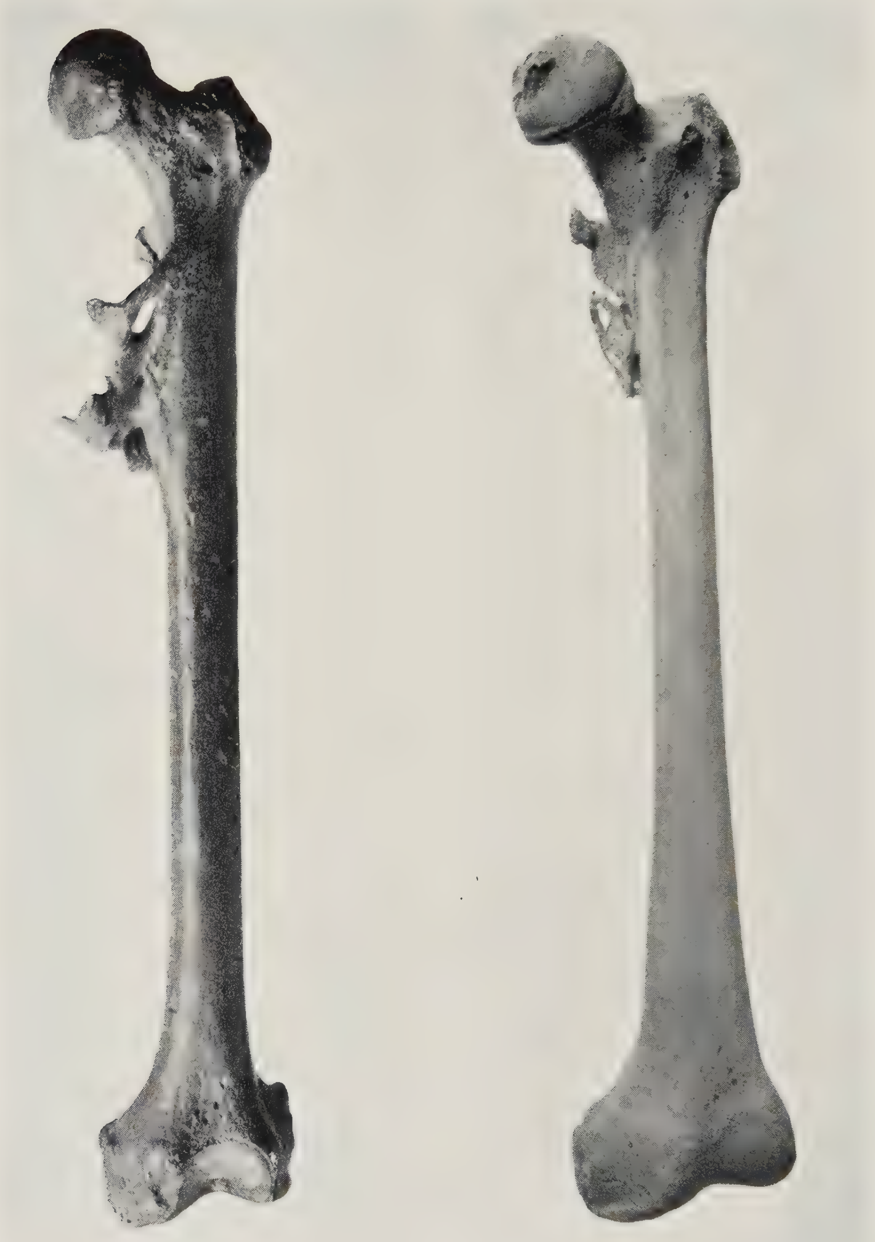
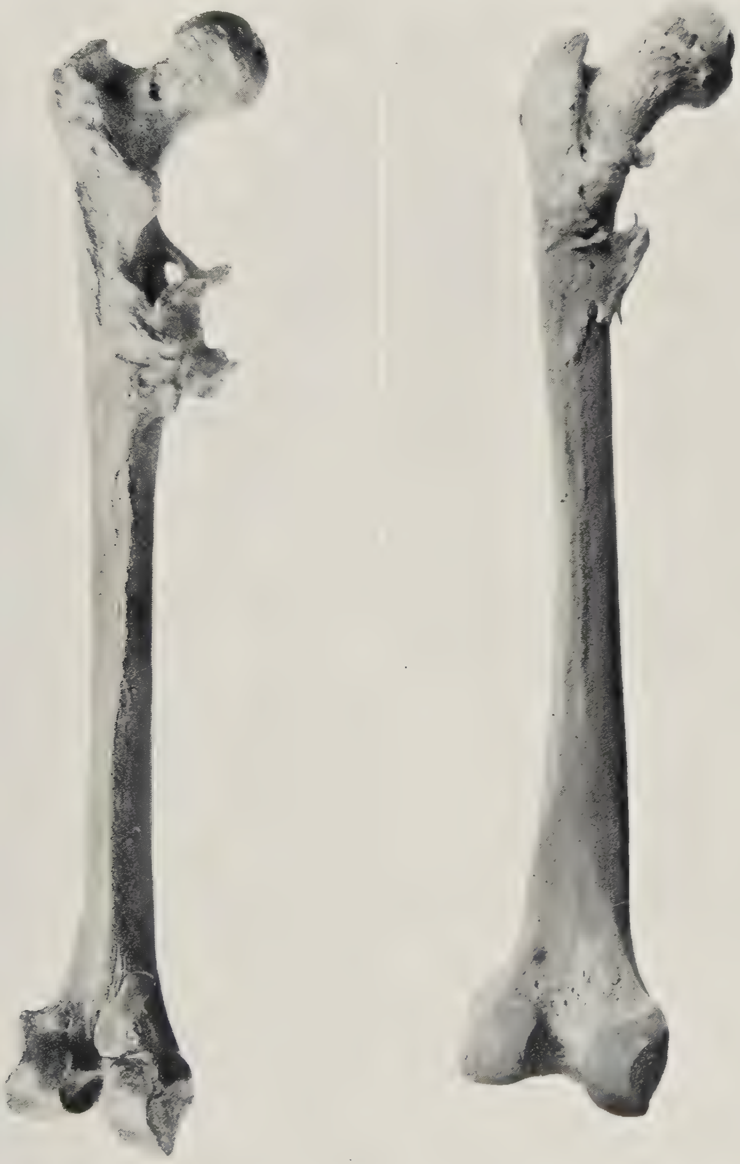
M 3
R

Pithecanthropus teeth. (After McGregor.)



Femur of Pithecanthropus (cast) and a femur of a White (American), showing same exostosis. (Photographed to same scale. Hrdlička)



Same as plate 10, rear view.

that a discovery had been made at Java of a second Pithecanthropus; and almost simultaneously I received at Washington the following letter:

> SOERABAIA (JAVA, NETHERLANDS, EAST INDIA),
> GENTENG KALI, NO. 12,
> AUGUST 22, 1926
>
> Prof. Dr. Aleš Hrdlička, U. S. National Museum, Washington.
>
> DEAR SIR:
>
> During your stay in Netherlands, East India, last year I was delighted to be present at your lecture on evolution in the building of the Fellowship of Arts ("Kunstkring") at Soerabaia. You then spoke, too, about Trinil, where years ago the Pithecanthropus was found, and as I am in great trouble now what to do with a discovery or—better said—a finding I made there, I take the liberty to apply to you with the demand for advice.
>
> The question is to whom shall I best give away the object I found, and I should be very glad if you would be so kind as to answer me. I myself was geologist about two years before I, now thirty years ago, studied medical science. Since I was almost twenty years medical officer in the Dutch colonial army and am now in civil service here, I always kept up as much as possible with my former palaeontological knowledge, nevertheless I remained only an amateur and by no means a savant in this branch of natural science and yet less in anthropology.
>
> On August 1st, thus now three weeks ago, I made an excursion to Trinil with Dr. de Graaf from Modjokerto and two gentlemen from the sugar factory Poerwodadi near Madioen. There we got a skull of a primate or man, something like the Pithecanthropus, though I am inclined to believe the shape is more man-like. The conservation is not very good; it is only a pouring off of the interior of a skull. The occiput is missing, but the two frontalia with the arcus superciliaris, the right and two-thirds of the left parietal, the upper part of the right and a little of the left temporal are very well poured off. The interior of the stone is typical porous lava. I suppose the proper bone of the cranium has been dissolved by the sulfuric acid of the lava. At any rate I think the object is very interesting.
>
> The question is now what to do with it. My first impulse was to send the remains to Holland. Once more I beg you to give me advice. I willingly shall wait for your answer.
>
> Yours sincerely,
> DR. C. E. J. HÆBERLEIN,
> Gov't Physician.

This announcement created, naturally, great interest and was reported upon in the Daily Science News Bulletin of September 29, 1926. A cable was sent to Java asking for photographs; and early in December there arrived a set of very good prints which showed the specimen in various positions.

At first sight these photographs made a strong impression. They appeared to show a skullcap of much the same type as that of the

Pithecanthropus. The skull cavity seemed to be filled with a mass of vesicular volcanic-like matter. Anyone who knew the form of the old Trinil cranium could readily have taken the specimen for a second skull of that nature.

However there seemed to be something amiss; and a view with a magnifying glass showed that the vesicular mass looked more like cancellous bone than stone. Mr. Gerrit S. Miller, Jr., whom I called to see the photographs, not only concurred in this but soon brought up an arm-bone of an Indian elephant, the head of which with its rim practically duplicated the Java specimen. An enlargement of one of the photographs to the size of the elephant's humerus made the identity of the two certain. The same day, curiously, came a despatch to the effect that Professor Dubois, to whom another set of the photographs was evidently sent at the same time, had made practically the same identification, referring the specimen to the extinct elephant (Stegodon) of Java.

A report on the very interesting occurrence was presented by the writer at the December meeting of Section H, American Association for the Advancement of Science, and a brief note was published by him in the American Journal of Physical Anthropology, 1927, Vol. 10, No. 1, p. 162. Meanwhile, on December 18, 1926, Dr. Dubois made his report on the find before the Academy of Sciences, Amsterdam, and this was published in 1927 in the Proceedings of the Academy, Vol. 30, No. 1, pp. 134-137, 3 figs. Later in 1927 there appeared finally the report of Dr. Mijsberg,[1] who saw the original, and this bore out completely the above identifications.

There is therefore no second Pithecanthropus; but though mistaken, as many would have been by the very suggestive specimens, Dr. Heberlein deserves thanks for both his praiseworthy effort in obtaining the specimen and for making so freely available excellent photographs which permitted a prompt and true identification of the bone.

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[1] Mijsberg, W. A., Over het in 1926 te Trinil gevonden en ten onrechte als rest van het schedeldak van een praehistorischen mensch beschouwde fossiel. Geneesk. Tijdschrift Nederlandsch-Indië, 1927.

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THE EOANTHROPUS

The name "*Eoanthropus Dawsoni*" (Dawson's Dawn-Man) was applied in 1912 (published in 1913) by Arthur Smith Woodward, then Keeper of the Department of Geology and Paleontology, British Museum (Natural History), to a number of fragments of a human-like skull, a portion of a lower jaw, and a separate canine tooth, found between about 1909 and 1912 in the old gravels of Piltdown, Sussex, England. To these were added two pieces of another skull and a molar tooth found by Dawson in 1915 among the stones raked off a field two miles distant. All these specimens are preserved in the British Museum (Natural History), South Kensington (London).

THE ORIGINAL FIND

The original find was reported by Dawson and Woodward before the Geological Society, London, December 18, 1912, and published in the Quarterly Journal of the Society, March, 1913; the second find being reported by Woodward in the same periodical in 1917. The original publications covering the discoveries are as follows:

Dawson, Charles, and Woodward, Arthur Smith, On the Discovery of a Palaeolithic Skull and Mandible in a Flint-Bearing Gravel overlying the Wealden (Hastings Beds) at Piltdown, Fletching (Sussex). Quart. Journ. Geol. Soc., Vol. 69, pp. 117-151, 1913.

———, Supplementary Note on the Discovery of a Palaeolithic Human Skull and Mandible at Piltdown (Sussex). *Ibid.*, Vol. 70, pp. 82-99, 1914.

———, On a Bone Implement from Piltdown (Sussex). *Ibid.*, Vol. 71, Pt. 1, pp. 143-149, 1915.

Woodward, Arthur Smith, The Piltdown Man. Geol. Mag., London, Decade V, Vol. 10, No. 592, pp. 433-434, 1913.

———, On a Second Skull from the Piltdown Gravel. Quart. Journ. Geol. Soc., Vol. 73, Pt. 1, pp. 1-10, 1917.

———, Fourth Note on the Piltdown Gravel. *Ibid.*, 1917.

———, A Guide to the Fossil Remains of Man in the Department of Geology and Palaeontology, British Museum (Nat. Hist.), 1st ed., 1915, 3d ed., 1922.

During the 15 years since the first report, a whole literature has grown up about these finds, due to their fragmentary condition, their insufficiency for definite conclusions, and the most disturbing apparent morphological incongruity of the specimens. It is another case where a desire to reach conclusions from insufficient and problematic material has led to a cloud of speculation and opinion, where substantial definite deductions are impossible.

As with the Pithecanthropus, so with the Eoanthropus, both in the discoveries and in subsequent history, there is much romance and psychology, besides prehistory.

The preservation of the find is due essentially to Mr. Dawson; and its history illustrates the usefulness and need, especially in the Old World, of scientific supervision of excavations. Mr. Dawson's original statement is as follows (Quart. Journ. Geol. Soc., 1913, Vol. 69, pp. 117 *et seq.*):

> Several years ago I was walking along a farm road close to Piltdown Common, Fletching (Sussex), when I noticed that the road had been mended with some peculiar brown flints not usual in the district. On inquiry I was astonished to learn that they were dug from a gravel bed on the farm, and shortly afterwards I visited the place, where two laborers were at work digging the gravel for small repairs to the roads. As this excavation was situated about four miles north of the limit where the occurrence of flints overlying the Wealden strata is recorded I was much interested and made a close examination of the bed. I asked the workmen if they had found bones or other fossils there. As they did not appear to have noticed anything of the sort, I urged them to preserve anything that they might find. Upon one of my subsequent visits to the pit, one of the men handed to me a small portion of an unusually thick human parietal bone.[1] I immediately made a search, but could find nothing more nor had the men noticed anything else. The bed is full of tabular pieces of ironstone closely resembling this piece of skull in color and thickness; and, although I made many subsequent searches, I could not hear of any further find nor discover anything—in fact, the bed seemed to be quite unfossiliferous.

---

[1] The men are said to have found the whole or nearly whole brain portion of the skull, to have taken it for a petrified "cocoanut," and to have broken it.

It was not until some years later, in the autumn of 1911, on a visit to the spot, that I picked up, among the rain-washed spoil heaps of the gravel pit, another and larger piece belonging to the frontal region of the same skull, including a portion of the left superciliary ridge. . . . .

I took the bones to Dr. A. Smith Woodward at the British Museum (Natural History) for comparison and determination. He was immediately impressed with the importance of the discovery, and we decided to employ labor, and to make a systematic search among the spoil heaps and gravel as soon as the floods had abated, for the gravel pit is more or less under water during five or six months of the year. We accordingly gave up as much time as we could spare since last spring (1912) and completely turned over and sifted what spoil material remained; we also dug up and sifted such portions of the gravel as had been left undisturbed by the workmen. . . . .

At Piltdown the gravel bed occurs beneath a few inches of the surface soil and varies in thickness from 3 to 5 feet. . . . .

Portions of the bed are rather finely stratified, and the materials are usually cemented together by iron oxide, so that a pick is often needed to dislodge portions—more especially at one particular horizon near the base. It is in this last mentioned stratum that all the fossil bones and teeth discovered *in situ* by us have occurred. The stratum is easily distinguished in the appended photograph (pl. 5) by being of the darkest shade and just above the bedrock.

The gravel is situated on a well-defined plateau of large area . . . . and lies about 80 feet above the level of the main stream of the Ouse.

Since the deposition of the gravel, the river has cut through the plateau, both with its main stream and its principal branch, to this extent.

Considering the amount of material excavated and sifted by us, the specimens discovered were numerically small and localized.

Apparently the whole or greater portion of the human skull had been shattered by the workmen, who had thrown away the pieces unnoticed. Of these we recovered from the spoil heaps as many fragments as possible. In a somewhat deeper depression of the undisturbed gravel I found the right half of a human mandible. So far as I could judge, guiding myself by the position of a tree 3 or 4 yards away, the spot was identical with that upon which the men were at work when the first portion of the cranium was found several years ago. Dr. Woodward also dug up a small portion of the occipital bone of the skull from within a yard of the point where the jaw was discovered and at precisely the same level. The jaw appeared to have been broken at the symphysis and abraded, perhaps when it lay fixed in the gravel and before its complete deposition. The fragments of cranium show little or no sign of rolling or other abrasion, save an incision at the back of the parietal, probably caused by a workman's pick.

A small fragment of the skull has been weighed and tested by Mr. S. A. Woodhead, M. Sc., F. I. C., public analyst for East Sussex and Hove, and agricultural analyst for East Sussex. He reports that the specific gravity of the bone (powdered) is 2.115 (water at 5° C. as standard). No gelatine or organic matter is present. There is a large proportion of phosphates (originally present in the bone) and a considerable proportion of iron. Silica is absent.

> Besides the human remains, we found two small broken pieces of a molar tooth of a rather early Pliocene type of elephant, also a much-rolled cusp of a molar of *Mastodon,* portions of two teeth of *Hippopotamus,* and two molar teeth of a Pleistocene beaver. In the adjacent field to the west, on the surface close to the hedge dividing it from the gravel bed, we found portions of a red deer's antler and the tooth of a Pleistocene horse. These may have been thrown away by the workmen, or may have been turned up by a plough which traversed the upper strata of the continuation of this gravel bed. Among the fragments of bone found in the spoil heaps occurred part of a deer's metatarsal, split longitudinally. This bone bears upon its surface certain small cuts and scratches which appear to have been made by man. All the specimens are highly mineralized with iron oxide. . . . .
>
> Among the flints we found several undoubted flint implements, besides numerous Eoliths. . . . .

From the above Mr. Dawson believed himself justified in drawing the following conclusions:

> It is clear that this stratified gravel at Piltdown is of Pleistocene age, but that it contains in its lowest stratum animal remains derived from some destroyed Pliocene deposit probably situated not far away and consisting of worn and broken fragments. These were mixed with fragments of early Pleistocene mammalia in a better state of preservation, and both forms were associated with the human skull and mandible, which show no more wear and tear than they might have received *in situ.* Associated with these animal remains are Eoliths, both in a rolled and an unrolled condition; the former are doubtless derived from an older drift, and the latter in their present form are of the age of the existing deposit. In the same bed, in only a very slightly higher stratum, occurred a flint implement, the workmanship of which resembles that of implements found at Chelles, and among the spoil heaps were found others of a similar, though perhaps earlier, stage.
>
> From these facts it appears probable that the skull and mandible cannot safely be described as being of earlier date than the first half of the Pleistocene (or Glacial) epoch. The individual probably lived during a warm cycle of that age.

ADDITIONAL FINDS

In 1915, before the same Geological Society, London, Mr. Dawson and Dr. Woodward report "On a bone implement from Piltdown."[1] It was found during the excavations of 1914,

> . . . . about a foot below the surface, in dark vegetable soil, beneath the hedge which bounds the gravel-pit, and within three or four feet of the spoil-heap whence we obtained the right parietal bone of the human skull. On being washed away, the soil left not the slightest stain on the specimen, which was covered with firmly-adherent pale-yellow sandy clay, closely similar to that of the flint-bearing layer at the bottom of the gravel. The bone, therefore, cannot have lain buried in the soil for any long period, and was almost certainly thrown there by the workmen with the other useless débris when they

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[1] Quart. Journ. Geol. Soc., Vol. 71, pp. 144-149, 1 pl., 1 fig., 1915.

> were digging gravel from the adjacent hole. It is much mineralized with oxide of iron, at least on the surface, and it agrees in appearance with some small fragments of bone which we found actually in place in the clay below the gravel. Its surface is yellowish brown, the cut facets being slightly darker than the rest; but the bony tissue within is yellowish or creamy white, and the whole is much less darkly stained than the bones from the gravel immediately above. As it lay in the rock it was broken across at its middle, and the two broken faces are stained like the rest of the bone; at its thinner end it was accidentally shattered by our workman's pick.
>
> The implement is a stout and nearly straight narrow plate of bone, 41 cm. long and varying from 9 cm. to 10 cm. in width, with the thicker end artificially pointed or keeled, the thinner end artificially rounded.

The bone is evidently a portion of a femur of a large proboscidean.

In 1917, finally, Dr. Woodward reports to the Geological Society the find by Mr. Dawson, on a field two miles distant from the original discovery, of two fragments of a second fossil skull and an additional molar. The main part of the report reads as follows:[1]

> The wide distribution of the Piltdown gravel, as determined by its characteristic brown flints, was shown by Mr. Dawson in his map of 1912. It could easily be traced in the ploughed fields of the district; but, notwithstanding the most careful and persistent search, it yielded no fossils, except at the original locality, until the winter of 1914-15. One large field, about two miles from the Piltdown pit, had especially attracted Mr. Dawson's attention, and he and I examined it several times without success during the spring and autumn of 1914. When, however, in the course of farming, the stones had been raked off the ground and brought together into heaps, Mr. Dawson was able to search the material more satisfactorily; and early in 1915 he was so fortunate as to find here two well-fossilized pieces of human skull and a molar tooth, which he immediately recognized as belonging to at least one more individual of *Eoanthropus dawsoni*. Shortly afterwards, in the same gravel, a friend met with part of the lower molar of an indeterminable species of rhinoceros, as highly mineralized as the specimens previously found at Piltdown itself.
>
> The most important fragment of human skull is part of the supraorbital region of a right frontal bone adjacent to the middle line. It is in exactly the same mineralized condition as the original skull of *Eoanthropus*, and deeply stained with iron-oxide. It is also similarly thickened, exhibiting the characteristic very fine diploe with comparatively thin outer and inner tables of dense bone. . . . .
>
> The second fragment of human skull is the middle part of an occipital bone, which is also well fossilized, but seems to have been weathered since it was derived from the gravel. Though still stout, it is thinner than the corresponding bone of *Eoanthropus* from Piltdown, and differs from the latter in at least one important respect. . . . .
>
> The tooth, discovered by Mr. Dawson in the same locality as the two pieces of bone, is a left first lower molar agreeing very closely with that of the original specimen of *Eoanthropus dawsoni*, but more obliquely worn by mastication. It is equally well fossilized, and stained brown with oxide of iron in the usual manner.

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[1] Quart. Journ. Geol. Soc., Vol. 73, Pt. I, p. 3, 1917.

RECAPITULATION

The specimens.—The remains attributed to the Eoanthropus consist of two lots, the first comprising nine fragments of a skull (joined now into four pieces), a pair of nasal bones, a portion of a lower jaw, and a canine; the second, two fragments of another skull and presumably a loose molar.

Locality, dates and discoverers.—The initial remains of the first group were unearthed from the ancient river gravels of the Ouse river, at Piltdown, near Fletching, in the weald of Sussex, between 1909 (approximately) and 1913, by laborers, but discovered, with additional finds, by Charles Dawson, A. Smith Woodward and P. Teilhard. The second lot is believed to have been found, in 1915, among the surface rakings of a field two miles from the site of the earlier discovery, by Dawson; it was not reported until 1917 by Woodward, on the basis of oral information given by Dawson.

Main circumstances of discovery.—The earlier remains " were first found by workmen when digging the gravel for use on roads, and among them was the human skull which they broke up and threw away. One fragment was fortunately preserved and given to Mr. Dawson, who recognized its importance and at once began a search for the remainder of the specimen. Enough pieces were recovered to show the essential peculiarities of the skull. Part of the lower jaw and the lower canine tooth were eventually found in the adjacent undisturbed gravel, and some implements of human workmanship and fragmentary remains of animals were also met with." [1]

Associations.—With the earlier remains were found worn fossils evidently washed out of Pliocene formations (mastodon, stegodon, rhinoceros); fossils of probably early Pleistocene age (hippopotamus, beaver, elk); and primitive stone implements, with one large crude tool of a bone of an elephant.

Significance.—The discoverers and the English anthropologists in general associate the first group of finds as those of one individual, the loose molar and possibly the parts of the second skull to another, and all the specimens as belonging to one early form of man, the Eoanthropus.

From the same gravels came also waterworn " eoliths," that may have been washed out from an even older formation; and rare flints with " obvious signs of human workmanship " [2] and representing a very old type of paleolithic implements.

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[1] Woodward, Arthur Smith, A Guide to the Fossil Remains of Man, etc., p. 9, *et seq.* British Museum (Nat. Hist.), London, 1915.

[2] *Idem.*

Geological age.—Taking all the circumstances of the find into consideration, Dr. Woodward decided that, "it appeared probable that the skull and mandible cannot safely be described as being of earlier date than the first half of the Pleistocene Epoch. The individual probably lived during a warm cycle in that age." (Quart. Journ. Geol. Soc., p. 123, 1913). In 1922, in his "Guide to the Fossil Remains of Man," etc., 3rd ed., pp. 10-11, Dr. Woodward says: "So far as can be judged from present evidence, it is therefore reasonable to suppose that Piltdown man dates back to the beginning of the Pleistocene period." The latter is about the generally accepted opinion today.

THE SKELETAL REMAINS

Descriptions of the various skeletal parts of the Piltdown finds, equally as excellent as the rest of his reports, are given in the original communications, already quoted, by Dr. Woodward. This author deserves the warm thanks of every anthropologist for, on the one hand, his highly able and restrained reports and studies, supplemented with beautiful illustrations; and on the other for the extended painstaking work in the Piltdown gravels, which he has carried on since 1912, first jointly with Dawson and, since Dawson's death, alone, and which he still pursues. The essentials of his observations will be incorporated in the following paragraphs.

THE FIRST SKULL

From the nine fragments of the cranium together with the portion of the lower jaw and the loose canine, a number of the most prominent students of the remains have attempted with infinite pains a reconstruction of the whole skull. The principal reconstructions are those of Woodward,[1] Elliot Smith with J. I. Hunter and J. Beattie,[2] Keith,[3] and McGregor.[4] These reconstructions differ somewhat in size and in details, but all show certain characteristics in common. They must be considered together with the originals; but it is the originals which demand first attention. The following notes combine the essential data on the specimens published by Dr. Woodward and other workers, with the writer's observations on the originals.

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[1] Quart. Journ. Geol. Soc., Vol. 69, p. 141, pl. XVIII, 1913. This reconstruction reminds one much of that of the skull of the Le Moustier youth, q. v.

[2] Nature, 1922, p. 726. Also Elliot Smith, The Evolution of Man, 2d ed., p. 74 *et seq.*, 1927.

[3] The Antiquity of Man, II, p. 515 *et seq.*, 1925.

[4] Illustrations in publications of Amer. Mus. Nat. Hist., N. Y.

Preservation.—The fragments are of dark red ferruginous color, and markedly mineralized. They are not deformed in any way, and apparently but little worn.

Massiveness.—Probably the most striking character of the bones of the skull (exclusive of the lower jaw), is their massiveness. The bones measure 8 to 12 mm. in thickness (Keith, Antiquity of Man, 1925, 518, 528), to 20 mm. at the internal occipital protuberance (Woodward, Quart. Journ. Geol. Soc., 1913, p. 124). This is just about twice the thickness of an average modern white skull. This thickness together with the depth of the grooves of the meningeal vessels and the unusual density (small spaces of the diploe) suggest strongly an abnormal condition, such as is met with in some of the Florida and other aboriginal skulls in America (Hrdlička), though no disease is detectable microscopically (Shattock, Proc. Inst., Med. Cong., Lond., 1915).

Age.—The skull is plainly that of an adult of somewhat advanced age. "The median parietal (sagittal) suture is completely obliterated; but the lambdoid suture is open" (Woodward, Quart. Journ. Geol. Soc., 1913, p. 128; Keith, Antiquity of Man, 1927, 545). Under normal present conditions, excluding a premature closure of the sagittal suture, the age of an individual with a complete obliteration of this suture could be estimated at 50 years and might be well over that. But there are exceptions (*e. g.*, in the Eskimo), particularly if the skull was not fully normal, as seems here to be indicated by the thickness of the bones; so that all that it is safe to say is that the skull belonged to an adult of probably over 30 years of age.

Sex.—The sum of the indications, it is generally recognized, are that the skull is that of a female.

Form.—The fragments of the skull (pl. 13), aside from their thickness, relative density of the cancellous bone, and a strong mark of attachment of the temporal muscle, offer but little that is extraordinary. The temporal fragment shows a moderate-sized mastoid, and a small but very distinct styloid.

The several reconstructions of the skull differ in certain respects. All these, however, show it to have been rather above medium in breadth (not far from the lower limits of brachycephaly). The height in the Smith Woodward original reconstruction is somewhat low, in those of Keith and Elliot Smith about or near the modern medium.

In the opinion of Dr. Woodward (Quart. Journ. Geol. Soc., 1913, 127), a detailed examination of the bones of the skull, as far as preserved, "proves the typically human character of nearly all the features they exhibit." For Keith, "except for the thickness of the skull bones, the head was shaped and balanced as in us" (Antiquity of Man, 1925, 570, 578, 595). It is a skull that "in its general conformation does not differ materially from human skulls of the modern type" (*ibid.*, 602). But for Elliott Smith (Evolution of Man, 1927, 74 *et seq.*) the skull, as reconstructed by him and his associates, exhibits a number of primitive characters.

The writer's opinion, after repeated study of the originals, is that while the fragments show a few peculiarities, these are not of a phylogenetically decisive nature, and seemingly could all be duplicated in the skulls of still living races.

Size.—The capacity of the skull has been estimated by the different authors who attempted its reconstruction, as follows:

	Approximately *cc.*
Smith Woodward's original estimate	1,070
Barlow's brain cast, first Smith Woodward reconstruction	1,200
Second Smith Woodward reconstruction	1,300
Elliot Smith	1,200
Keith	1,400

If the skull was that of a female, as is most probable, its mean approximate diameter $\frac{(LBH)}{3}$, after reduction for the extra thickness of the specimen, would indicate an internal capacity of about 1,300 cc.[1]

Other measurements.—The several reconstructions of the skull made possible approximate measurements, the most important of which are given here:

	Woodward, A. S.[2] *cm.*	Keith[3] *cm.*
Length max.	19.0	19.4
Breadth max.	15.0	15.0
Cranial index	*78-79*	*78-79*
Height:		
Basion-bregma	13.0	...
Basion-vertex	13.0	...
Auricular	...	11.7
Glabella-inion line, vertex	9.0	...
Glabella-inion line, bregma	8.4	...
Nearest approach of upper temporal line to median line.	3.6	...
Nearest approach of lower temporal line to median line.	4.6	...

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[1] See Relation of the size of the head and skull to capacity in the two sexes. Amer. Journ. Phys. Anthrop., Vol. 8, pp. 249-250, 1925.

[2] Quart. Journ. Geol. Soc., Vol. 69, p. 130, 1913.

[3] Antiquity of Man, pp. 528 *et seq.*, 576-577, 589-591, 595, 600, 1925.

The various determinations show that:

1. The skull, taken as female, was in size above rather than below the present average of female crania;

2. The skull cavity and hence the size of the brain were about the average of the ordinary white females of today;

3. The vault of the skull was not low as in all the other known early forms of man.

In addition it is certain that the forehead of this skull was well arched and filled out; the parietal, temporal, and occipital regions were fashioned practically as they are in modern skulls (Keith, p. 556); the supraorbital ridges were very moderate and did not form a connected arch; there were no occipital or other crests; the glenoid fossa and the mastoids were well developed.

In general this skull, though it may show some secondary inferiorities, if it were not for the exceedingly primitive lower jaw and canine tooth found near it, would inevitably have to be classed among those of modern man.

The nasal bones.—These bones, together with a portion of a turbinal, were found in 1913 by Dr. Woodward, as mentioned above.[1] They are extraordinarily thick, corresponding in this respect to the bones of the skull. They are separate (no ossification of suture), and almost perfectly preserved; the left nasal being complete, the right but slightly defective. Their measurements are thus given by Dr. Woodward:[2]

	mm.
Width of naturally apposed nasals at the upper end	13
Width of naturally apposed nasals at the lower end (about)	15
Length of the median suture	14
Length of the nasals, max	18
Length of the upper border of the left nasal	7
Length of the upper border of the right nasal	10
Length of the lower border of the left nasal	10
Length of the lower border of the right nasal (about)	11

Comparisons prove, according to Dr. Woodward, that "these nasal bones resemble those of the existing Melanesian and African races, rather than those of the Eurasian type" (p. 87). Nevertheless similar nasals, except as to the thickness, may be found also in the yellow-brown people and even in whites (Hrdlička). The turbinated "is unusually thick" (Smith Woodward). There is every indication that the nasals as well as the turbinated belong to the skull and were in all probability still joined with it when it was originally found by the laborers. They strengthen the suspicion that the skull may be not fully normal (Hrdlička).

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[1] Original report in Quart. Journ. Geol. Soc., Vol. 70, p. 85, 1914.

[2] *Ibid.*, p. 87.

THE BRAIN

All that can be known about the brain of the Piltdown skull is what is shown by the internal surface of the several fragments; and, as there is but a portion of the side of the front and no base, not to mention other large defects, it is plain that the obtainable information must be quite meagre. If notwithstanding this we find in the literature on the subject some far-reaching statements, these cannot be taken for much more than opinions; and with the defects of the original it is no wonder that some of these opinions, even by the best men, differ widely.

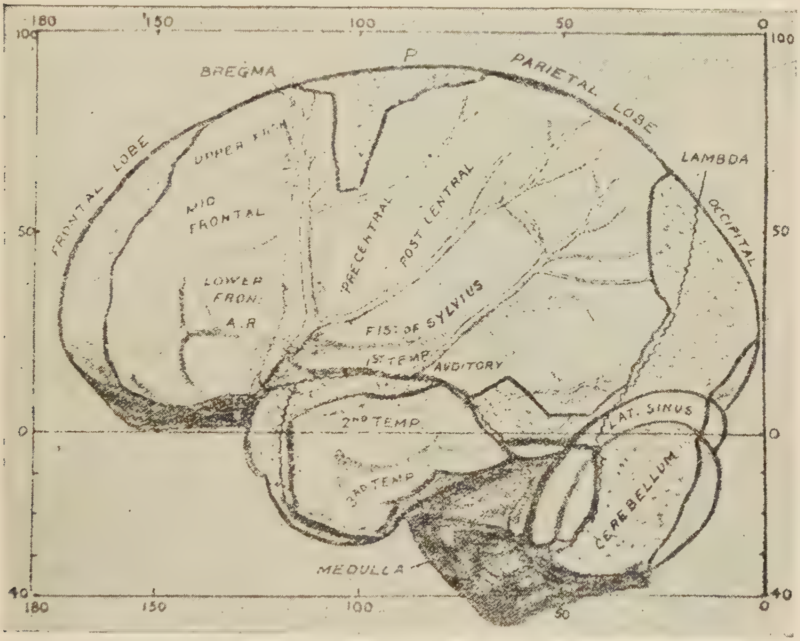
180
150
100
50
0
100
50
0
40
BREGMA
P
PARIETAL LOBE
LAMBDA
OCCIPITAL
FRONTAL LOBE
UPPER FRON.
MID FRONTAL
LOWER FRON.
A.R
PRECENTRAL
POST CENTRAL
FIS: OF SYLVIUS
1ST TEMP.
AUDITORY
2ND TEMP.
3RD TEMP.
LAT. SINUS
CEREBELLUM
MEDULLA
180
150
100
50
0

Fig. 8.—Profile drawing of the brain cast taken from the reconstruction of the Piltdown skull by Arthur Keith. It is represented half size and set within a standard frame of lines which permits direct comparison between the various drawings given here. The positions of the sutures between the containing bones are indicated. The missing parts are stippled. (After Keith, Antiquity of Man, 1925.)

Thus, Professor G. Elliot Smith, one of the foremost living students of the brain, in his "Preliminary Report on the Cranial

Cast,"[1] says: "Taking all its features into consideration, we must regard this as being the most primitive and most simian human brain so far recorded." In his 1927 treatise on the "Evolution of Man" (pp. 126-127) Professor Smith is much less explicit, but mentions a number of details in which he believes the brain was inferior, and it is plain that he still regards it much as he did before.

On the other hand, Sir Arthur Keith, unquestionably one of the foremost living anatomists of the present time, concludes,[2] after an at least equally painstaking study of the originals and their casts, that so far as the more basal parts are concerned, "we have seen no feature of the Piltdown brain to which we can apply with any certainty the term of primitive or simian; all the characters we have encountered are not very unlike those seen in modern skulls and brains" (p. 620); and "it appears, even in its convolutionary arrangement, to fall well within the limits of variation seen in modern human brains" (p. 621). "In the development of the occipital poles of the brain, this early Pleistocene man shows, not a primitive feature, but one which must be regarded as evidence of a fairly high degree of specialization" (p. 627). And finally (p. 634): "Thus an examination of the brain cast confirms the conclusion reached from an examination of the skull, namely, that a mistake was made in the identification of the parts lying in the middle line which greatly diminished the real size of the brain, and these mistakes continue to be made. . . . . The asymmetry of the two sides has largely disappeared. The arrangement of the meningeal vessels and of the convolutions of the left side are seen to harmonize with those of the right. At the same time the large areas of the brain, representing the higher association centres, are restored, and we obtain a brain primitive in some respects, it is true, but in all its characters directly comparable with that of modern man."

THE LOWER JAW

The lower jaw, as stated, was found personally by Dawson, apparently close to the spot where the skull was discovered, in "a somewhat deeper depression of the undisturbed gravel" (Quart. Journ. Geol. Soc., 1913, p. 121). "The jaw appeared to have been broken at the symphysis and abraded perhaps where it lay fixed in the gravel and before its complete deposition. The fragments of the cranium show little or no signs of rolling or other abrasion" (*ibid.*).

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[1] Quart. Journ. Geol. Soc., Vol. 69, p. 147, 1913.

[2] Antiquity of Man, 1925.

It is this jaw, together with the subsequently found canine, that has become the great " bone of contention " in the case. The reason

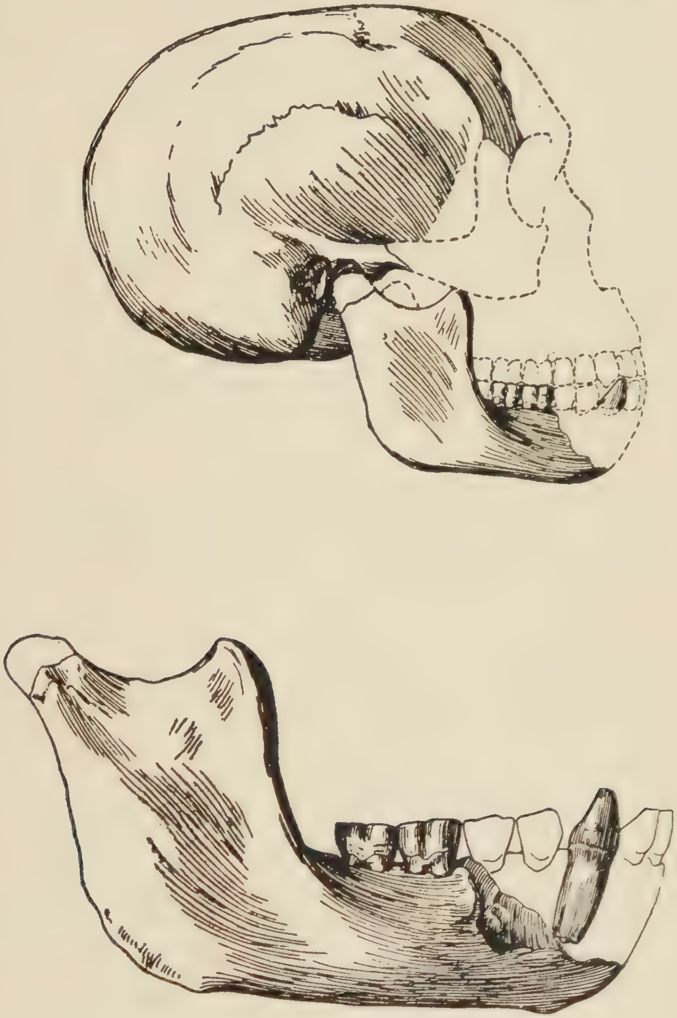

FIG. 9.—*Eoanthropus dawsoni* Smith Woodward. Pleistocene gravel, near Piltdown Common, Fletching, Sussex, England. (After Smith Woodward, Geol. Mag., 1913, pl. 15.)

is that, as tersely stated by Dr. Woodward,[1] " while the Piltdown skull is thus completely human, the half of the lower jaw, so far as preserved, is almost precisely that of an ape." And in another place[2]

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[1] A Guide to the Fossil Remains of Man, etc., p. 15, 1915.

[2] Geol. Mag., Vol. 10, pp. 433-434, 1913.

Dr. Woodward expresses the uncertainty thus created: " It may next be questioned whether this ape-like mandible belongs to the skull. We can only state that its molar teeth are typically human, its muscle-markings are such as might be expected, and it was found in the gravel near to the skull. The probabilities are therefore in favour of its natural association. If so, it is reasonable to suppose that the skull will prove to be that of a very primitive type, not that of a highly civilized man."

No such jaw, or even an approach to it, has ever before or since been found with such a skull. The two apparently do not belong to the same being nor even to the same species of beings. In other early remains, especially in one of the Spy skulls, at La Quina, and in the La Ferrassie specimens, it was the jaw rather than the skull that showed a form advancing towards the modern. The probabilities of the discovery speak apparently all for, the morphological features of the specimens all against, an organic association of the skull with the jaw.

The inevitable results of this disharmony were, from the start, expressions of dissenting opinions, which culminated when in 1915 and again in 1918, after a serious study of the cast of the fragment, Gerrit S. Miller, Jr., identified the jaw as that of *Pan vetus,* a fossil chimpanzee.[1]

In 1917 Dr. Woodward announced the discovery of parts of the second skull, together with a loose molar, both evidently connecting with the first find, the skull bones with the skull, the tooth with the jaw, which served but to accentuate the uncertainties.

In 1921, thanks to Dr. Woodward, the writer was given an opportunity, in London, to study the Piltdown originals; the same privilege was again extended in 1923, when once more the originals, preserved in the safe of the Department of Geology and Paleontology of the British Museum (Natural History), were measured and examined; and they were seen again in 1925. The results of the 1921-23 examinations were published in several articles in the American Journal of Physical Anthropology,[2] and in view of the importance of the case the essential parts of these are here reproduced. The results of the 1925 examination call for practically no modification of the earlier data.

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[1] The Jaw of the Piltdown Man. Smithsonian Misc. Coll., Vol. 65, No. 12, 31 pp., 5 pls., and annotated bibliography of the subject up to that time, 1915; and The Piltdown Jaw, Amer. Journ. Phys. Anthrop., Vol. 1, 4 pls., with annotated bibliography of over 120 titles by more than 50 authors, 1918.

[2] Hrdlička, A., The Piltdown Jaw. Amer. Journ. Phys. Anthrop., Vol. 5, pp. 337-347, 1925. Dimensions of the First and Second Molars, with their Bearing on the Piltdown Jaw and on Man's Phylogeny; *ibid.,* Vol. 6, pp. 195-216, 1923; and Variation in the Dimension of Lower Molars in Man and Anthropoid Apes; *ibid.,* pp. 423-438.

The handling of the original bone impressed one once more with the great difference that exists between the study of a cast however well made and that of the original. It is very probable that some of the statements made about the jaw and the teeth and some of the conclusions arrived at by some authors, would not have been made had they been able to study the jaw itself.

The first strong impression which the specimen conveys is that of normality, shapeliness and relative gracility of build rather than massiveness. When, after studying the specimen for a good part of two days, the observer took in hand the thick Piltdown skull, there was a strong feeling of incongruity and lack of relationship, and this feeling only grew on further study. As a rule there exists a marked correlation between the massivity of the skull—particularly if as in this case the upper facial parts were involved in the same—and the lower jaw. A finely chiselled mandible of medium or sub-medium strength belongs as a rule to a skull that is characterized in the same way, and *vice versa.* To connect the shapely, wholly normal Piltdown jaw with the gross, heavy Piltdown skull into the same individual, seems very difficult. After prolonged handling of both the jaw and the skull there remained in the writer a strong impression that the two may not belong together, or that if they do the case is totally exceptional.

The next important question in connection with the jaw was whether or not it is human. All possible pains were taken to determine this point, regardless both of the skull and of previously expressed opinions. The details of this study will follow. But it may as well be said at once that all the results of the study point to the specimen being very early human or that of an advanced human precursor, and not anthropoid.

Other questions were whether the canine tooth found near the jaw belonged to it or not; and if it did not whether it could have belonged perhaps to the upper jaw of the same being or a being of the same variety. Upon these questions no absolute certainty could be reached; but the indications are that the jaw possessed a relatively large canine, and a further study of the tooth admits of the possibility that it belonged not merely to the same individual, but that after all it may be the lower right canine of the jaw. Mr. Miller, who in the writer's knowledge subjected the available data as well as the casts to a most careful study,[1] was at a disadvantage due to the impossibility of studying the originals.

DETAILED OBSERVATIONS

The Jaw: The specimen is in a very good state of preservation. Besides the well-known lack of condyle and the alveolar arch anterior to the first molar, there is no other damage except a slight abrasion of the middle portion of the posterior border of the ramus.

The specimen is not heavy in weight nor massive in structure; it is marked in fact by relatively moderate build, strikingly at odds with both the first and second Piltdown skulls which in all their parts are decidedly thick. There is no perceptible correspondence between the jaw and the skulls.

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[1] See Miller, G. S., The Piltdown Jaw. Amer. Journ. Phys. Anthrop., Vol. 1, No. 1, 1918.

The ascending ramus gives the writer the following measurements: Height along the middle to lowest point of notch, 6.1 cm.;[1] minimum breadth (allowing for slight damage of the posterior border), 4.25 cm. The angle is close to 112°. These measurements show little that could be regarded as biologically distinctive and could be duplicated in man as well as in some chimpanzees.

The ramus, finely formed, is of only moderate strength. Both the processes, coronoid and condyloid (the condyle itself is lost), were of about medium human development and quite human in form. This is particularly true of the coronoid, which is sharper and pointing somewhat more forward than it generally is in the chimpanzee.

The notch between the condyloid and coronoid processes is broad and typically human in form; in chimpanzees it is as a rule less broad, its posterior portion predominates in length and it has lesser inclination than the anterior part.

Features of special interest are the neck of the condyle and the posterior border of the ramus. The neck of the condyle is rather short and decidedly more slender than it is in chimpanzees, and even in most male modern human jaws. Below the neck the posterior border is rather sharp and towards the angle shows slight inversion rather than eversion, as not seldom in chimpanzees where the internal pterygoid muscles predominate in "pull" over that of the masseter externally; the same condition may also be met in some humans where the masseters were not well developed.

That the masseters in the Piltdown specimen were not strongly developed is shown by the smoothness of the outer surface of the angle portion of the jaw which is free of insertion ridges or irregularities. Such a condition is occasionally approached in chimpanzees though there are usually plain indications of the attachment of the muscle; it is clearly approached in some human jaws. The internal pterygoid muscle, attached to the internal surface of the ramus between the mylohyoid groove and the angle of the bone, and serving essentially for protrusion, retraction and in lateral movements of the jaw, in the chimpanzees as a rule predominates in strength and hence in marks of attachment over the masseter, and it does so also in a certain proportion of humans; but in many humans the extent of the attachment of the pterygoid, even though it may reach the mylohyoid groove is more or less reduced, and in not a few it is the masseter which predominates in strength producing a more or less marked eversion of the lower border of the bone at the angle. In the Piltdown jaw the attachment of the internal pterygoid, while reaching as far as the mylohyoid groove, left only faint traces of its attachments, less even than in many present day human jaws. Nevertheless, the masseter was evidently even weaker, due to which fact the border at the angle is slightly inverted as already mentioned.

The external surface of the ramus in the Piltdown jaw shows a marked and hitherto unmentioned depression produced by the body of the masseter. The depression begins superiorly just below the condyle and proceeds unevenly forwards and downwards to end in a large shallow concavity over the lower third of the ramus anterior to its middle. Of a similar depression there is found in the grown chimpanzees at most only the anterior portion. In human subjects this fossa is also frequently more or less deficient and irregular; nevertheless, there is on the whole a closer approach to it than in the chimpanzees; and in one of the skulls seen at the British Museum (Australian, No. 1068-4), as well as in several jaws at the U. S. National Museum, there is a very close approach to the condition such as seen in the Piltdown mandible.

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[1] The condyle, as is well known, is missing; with the condyle and measured in the usual way (see A. Hrdlička, Anthropometry, Wistar Inst., Phila., 1921), the height of the ascending ramus would be about 7.0 cm. or slightly over.

The anterior border of the ramus is somewhat thicker and duller than it is in an average modern human jaw, especially in that of a cultured white man. It is near to the average border in a chimpanzee; but it is a feature of little diagnostic value, being an expression of strength and not derivation. An equally thick border may be found in some human jaws, while in some chimpanzees as in most modern humans the edge is thinner.

Internally the upper portion of the ramus shows nothing especially characteristic. The impression for the external pterygoid is faint, that for the temporalis well marked but of moderate extent. The ridges and depressions, and the location of the mandibular foramen with the hyoid groove, present nothing that is not fairly common in both man and the chimpanzees.

Taking the ascending ramus as a whole, the conclusion is inevitable that it belonged to an individual in whom all the muscles of mastication (internal pterygoid, masseter, external pterygoid as well as temporal) were of only moderate development and activity for a being of the size indicated by the jaw. They were decidedly less than those of actual male chimpanzees, and possibly even a trace less than the average in the females of this form. On the whole the ramus, while bearing some resemblance to that of a chimpanzee in the slight inversion of its posterior border about the angle and the thickness of the anterior border, shows a closer approach to the human type than to that of the chimpanzee.

The horizontal part or body of the jaw.—The horizontal ramus of the Piltdown jaw, broken off superiorly in front of the first molar and inferiorly near the symphysis, shows a relatively light structure, comparable much more to a stronger modern human jaw than to that of a chimpanzee. The break shows that the ramus possesses a large cavity (which may have been partly filled by cancellous tissue) that reached without much diminution clear to and evidently through the chin. This condition differs markedly from that of the jaws of chimpanzees, in which the bone is thicker and the internal cavity smaller, particularly at the chin which is filled with sparse and dense cancellous tissue as hard as the compact walls outside of it, and in which the formation by natural means of a similar cavity as seen in the Piltdown specimen seems impossible. This is one more and an important feature, indicating a relatively light use of the jaw, less than in any known chimpanzees.

The body appears relatively somewhat low, which in man would indicate a female rather than a male individual; but it could also be a primitive feature. Low bodied jaws are a general feature in the chimpanzees. The vertical height of the body in the Piltdown jaw at the first septum anterior to the first molar, is 3.0 cm.; at the second septum (between first and second molars), 2.9 cm.; and at the third septum (between second and third molars), 3.0 cm. In a series of male chimpanzees in the U. S. National Museum the height at the septum between the second and third molars on the right side measures respectively 2.75, 2.8, 2.4, 2.8, 2.65, 2.9, 2.8, 2.85, 2.65, and 2.9 cm. None of the chimpanzee jaws, although most of them are males and larger than the Piltdown specimen, measure even as much as it does in the height of the body.

The minimum thickness of the body (at first molar) of the Piltdown jaw is 1.45 cm. This is above the average of both human and chimpanzee jaws, but is occasionally equalled and even exceeded in both. There is therefore nothing distinctive in this respect.

The external surface of the body shows the usual somewhat indistinct *oblique line*. There is nothing characteristic in it for either man or chimpanzee. This external surface shows also, however, an important feature that has so far failed to receive due attention. This is a basal ridge forming a boundary between the external surface proper of the bone, and the inferior flattening that gradually enlarging proceeds under the fore part of the jaw where it forms a shelf such as exists more or less in ape and other jaws that have a negative chin. The ridge above this shelf is not found in modern man except rudimentarily. It is already rather rudimentary in the Mauer jaw. It is well marked in the Piltdown jaw, and it is occasionally fairly well marked in an adult chimpanzee. It is caused by the shelf but even more so by the large and long canine eminence due to a large canine. It does not exist, or exists only in traces wherever the canine tooth is small as in the chimpanzee females and the young, or in modern man. Its presence in the Piltdown jaw seems a very strong indication that the jaw possessed a relatively large canine tooth; and this, with other considerations, increases the probability that the Piltdown canine belonged to the jaw, or at least to the same or a like skeleton.

The development of the sub-mentoneal shelf in the Piltdown jaw equals that of most chimpanzees—except, as already mentioned, in the solidity of the structure which in this case was plainly less than in any of the apes. A shelf of this nature is found in none of the ancient human jaws, though they all show traces of it. Traces of it may in fact be detected even in some modern jaws of man. In this feature, and in the indicated presence of a relatively larger than human canine, the jaw stands apart from all those of early man that have so far been discovered, and is correspondingly nearer to the chimpanzee or some related ancient anthropoid form. But neither of these features can be taken as conclusively diagnostic of a chimpanzee nature of the jaw. All that we would seem to be justified in saying is that in these respects, as well as in one or two others, the bone resembles more that of an ape than man. But as we cannot but believe that the human lower jaw in its evolution must have passed through such stages, these features do not legitimately hinder us, if other characteristics so urge, from placing the jaw in the line of early man or his precursors.

The lingual surface of the body of the jaw is quite smooth and presents nothing distinctive for either man or ape except the height of the body which on the inside even more than on the outside approaches the human type. The height of the body from the middle of the lingual border of the 3M alveolus is 3.0 cm.; in the adult chimpanzees of the U. S. National Museum it was found to be respectively 2.8, 2.7, 2.8, 2.5, 2.75, 2.4, 2.6, 2.85, 3.0, 2.7, 2.6, 2.9, and 2.6 cm. In the Mauer jaw this height was 3.3 cm.; while in modern human jaws a height of 3 cm. or even slightly over is quite common in males; in females it is lower. If the Piltdown jaw represents a female, as seems most likely, the male jaw of the same species would have been even higher and well beyond the range of variation of the chimpanzee.

The teeth.—The alveoli and interalveolar septa in the Piltdown jaw show little that could be regarded as distinctive in form; but they are larger antero-posteriorly, particularly in the case of the 3M, than in any chimpanzee available for comparison, coming much nearer the alveoli in some human mandibles with macrodont teeth. The total length in the median line of the three alveoli is 3.9 cm.; in the Mauer jaw it is 3.8 cm.; in some modern human jaws with large teeth it ranges from 3.6 to 3.9 cm.;[1] in the available male chimpanzees it varies from 3.0 to 3.4 cm.;[2] in chimpanzee females from 3.1 to 3.25 cm. The size of the three molar alveoli in the Piltdown jaw is plainly not chimpanzee-like, but stands close to early and macrodont recent human.

The breadth of the molar alveoli in the Piltdown mandible is just 10 mm. for each alveolus. This is also larger, and that by from 0.5 to 2.5 mm., than that of corresponding alveoli in any of the available chimpanzees,[3] but is equalled or closely approached in the Mauer (M1, 10; M2, 10.5; M3, 10 mm.) and in some modern human jaws with large teeth (Australian, No. 255,715, M1, 10.2; M2, 10.2; M3, 10.1 mm.; New Britain, No. 226,107, M1, 10; M2, 10; M3, 10 mm.; Arkansas Indian, No. 262,587, M1, 10; M2, 10; M3, 10 mm.; etc.)

The dimensions of the alveoli in the Piltdown jaw, together with the two remaining teeth (rM1, M2), show that the teeth were large. They were larger than any chimpanzee molars that are available for comparison. The Piltdown man or woman, like the jaw of Mauer and probably also other early human jaws (La Chappelle, La Quina), came therefore in all probability from a macrodont ancestry. As the bone mass and the musculature of the jaw are both reduced, the size of the teeth cannot be regarded as an individual peculiarity.

The two teeth themselves are naturally of much importance. They in a way resemble both the molars of some chimpanzees and those of some men. But they possess important characteristics that separate them from the ape teeth and approach them closer to human. They are somewhat more dolichodont (relatively long and narrow) than most human molars, but individual human teeth equalling them occur. In chimpanzees dolichodont molars are more frequent though there are also many exceptions; but in general the type of the crown in the chimpanzee is somewhat different.

The two anterior cusps in each of the teeth in the Piltdown jaw were stout and close together as in many human teeth. In the chimpanzees as a rule these cusps are smaller and farther apart.

In the chimpanzees the enamel part on the sides of the molars is lower (less in height) than in man; in the Piltdown jaw the conditions are about the same as in man.

In the Piltdown jaw, as occasionally in man, the enamel on the outside and slightly also on the inside extends in a pointed way towards the notch between the roots of the teeth. No such condition was found in the chimpanzees, though occasionally the limits of the enamel in their teeth are not easy to determine.

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[1] Australian (U. S. N. M. Cat. No. 255,715), 3.9 cm.; Peruvian Indian (No. 293,249), 3.7 cm.; New Britain (No. 226,107), 3.6 cm.

[2] Males: U. S. N. M. Cat. No. 84,635 = 3.3 cm.; No. 174,704 = 3.3 cm.; No. 174,710 = 3.0 cm.; No. 176,226 = 3.1 cm.; No. 176,227 = 3.1 cm.; No. 176,228 = 3.3 cm.; No. 176,230 = 3.3 cm.; No. 176,235 = 3.3 cm.; No. 176,244 = 3.4 cm.

Females: U. S. N. M. Cat. No. 176,700 = 3.25 cm.; No. 174,701 = 3.2 cm.; No. 174,706 = 3.1 cm.; No. 176,229 = 3.1 cm.; No. 176,243 = 3.1 cm.

[3] In the strongly developed male No. 174,699 the alveoli for the first and right second molars just reached 10 mm., but those for the other molars in the jaw are slightly to markedly smaller.

The crown of the chimpanzee molars in the majority of cases shows, particularly externally, a marked bulge just above the gum ("cingulum"), from which the cusps slope more or less upwards. Externally this slope is sometimes very decided. In man, and that in early as well as recent man, the bulge mostly becomes just a convexity and the cusps are more vertical, making the surface of the crown larger. In the Piltdown teeth conditions are exactly as in human molars.

The Piltdown molars are moderately worn down to the level of the depressions between the cusps. These depressions as far as preserved, and the wear itself, are very much as they are in man. In the chimpanzees such depressions show some differences from both the prevalent human and the Piltdown type, and the wear of the teeth is generally irregular. But there is a chimpanzee jaw of the National Museum series (No. 84,655) in which the wear is about the same as in the Piltdown and many human molars, and there are not infrequently human molars in which the wear will be irregular. Nevertheless, in this feature again as in other characteristics of the crown, the Piltdown teeth range themselves on the whole closer to human than to the chimpanzee type.

The crowns of the Piltdown teeth, in their height, find nothing resembling them in the teeth of the chimpanzee, but are closely like those of both early and modern man. This is one of the most important features in which the Piltdown specimen differs from the apes. The height of the crown from the uppermost part of the root notch to the level of the base of the furrows between the cusps, is externally in each of the Piltdown molars 8.5 mm. This can readily be duplicated in man; but the available chimpanzees give only (M2): 5.5; 6.0; 6.5; 6.0; 6.5; 7.0; 6.5; 6.0; 6.0; 6.0; 6.5; 6.0 mm. The Piltdown, Mauer, Brelade (Jersey) and recent human teeth (in general) are high-crowned or hypsodont; the chimpanzees are as a rule low-crowned or chamaedont. A jaw with molars such as those of the Piltdown specimen cannot be that of a chimpanzee, unless we should arbitrarily assume some old form of that genus that was radically closer than recent chimpanzees are to the human type.

The height of the enamel on the crown is in general difficult to measure due to the irregularity of its lower limits. In the Piltdown teeth the condition is further aggravated by the wear of the teeth. Notwithstanding all this, it can be estimated that the enamel layer of the Piltdown molars averages externally very close to 6 mm. without the cusps and that with the latter it reached 7.5 mm. These dimensions are common in man, both old and recent; but they are never it seems equalled in the chimpanzees. Taking the total height of enamel on the external surface of the Piltdown molars, with the cusps restored, as 7.5 mm., the nearest approach in a chimpanzee (British and U. S. National Museums) was 6.5 mm., and from this the measurements ranged to 5 mm., the most frequent figures obtained being 5.5 and 6 mm. Here then there is again an important difference.

The size of the individual molars in the Piltdown jaw is for M1, length along middle, 13 mm., breadth max. at right angles to length, 11 mm.; M2, length 13 mm., breadth 11 mm.; length-breadth index of each *84.6*. The worn surface of the crown of the second tooth appears to the eye a trifle larger than that of the first molar, but on measurement the teeth are found to be so closely alike that a distinction is difficult. The little difference that there is, is limited (as not seldom in other cases) to the trituration surface of the crown.

A good deal of weight has been placed upon the excess in the Piltdown teeth of their length over the breadth. It was apprehended as an inferior character and one placing the teeth nearer in type to those of the chimpanzee than to those of man. Upon closer examination into the subject this view is hardly sustained. On one hand we find individual human teeth both recent and ancient that closely approach the Piltdown molars; while on the other it is found that chimpanzee molars also are in general relatively shorter.

LENGTH, BREADTH AND INDEX OF THE PILTDOWN AND OTHER MOLARS

	Side	Length in median line	Breadth max.	B-L Index	Length	Breadth	Index
		M1			M2		
		mm.	*mm.*		*mm.*	*mm.*	
Piltdown Jaw........	r.	13.0	11.0	*84.6*	13.0	11.0	*84.6*
Piltdown, extra tooth.............	l.	13.0	11.0	*84.6*	.....	.....	....
Early Man: Mauer...	r.	11.5	11.5	*100.0*	11.5	11.5	*100.0*
Ehringsdorf.......	l.	12.0	11.0	*91.7*	12.5	11.0	*88.0*
Modern Macrodonts:							
Nat. Mus. Cat. No. 226,107, New Britain.....	l.	13.0	12.0	*92.3*	12.0	11.0	*91.7*
No. 262,587, Arkansas........	r.	12.0	11.5·	*95.8*	11.5	10.5	*91.3*
No. 304,095, Eskimo.........	l.	12.0	11.0	*91.7*	11.0	11.0	*100.0*
Nos. 320,916–53, White U. S......	l.	11.5	10.0	*87.0*	11.0	10.0	*90.9*
Chimpanzees:[1].......	Aver.	11.43	10.36	*9.06*	11.50	10.60	*92.0*
7 Males...........	r.	(10 to 12)	(9.5 to 11)	(*87.0* to *95.0*)	(11 to 12.5)	(10 to 11)	(*87.0* to *95.5*)
	Aver.	11.25	10.0	*88.9*	11.10	10.25	*92.1*
4 Females.........	r.	(11 to 11.5)	(9.5 to 10.5)	(*86.4* to *95.5*)	(10.5 to 12)	(9.5 to 11)	(*87.5* to *100*)

Among the remains of early man the majority of the bones and teeth are, regrettably, so imperfect that exact measurements of the molars are impossible; but a remarkable resemblance to the Piltdown teeth is found in the molars of the recently discovered lower jaw of Ehringsdorf, Germany. The figures on this page show the measurements of the teeth in various specimens.

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[1] Taking all the available specimens, hence also those in which one of the two anterior molars is missing, we find one sole tooth, the first right molar of male chimpanzee jaw No. 176,227, U. S. N. M., in which the index comes near being that of the Piltdown teeth; the dimensions of this molar are: L., 12.0; B., 10..0; Index, *83.3*. Individual human molars of this form could doubtless also be discovered.

CONCLUSIONS

A detailed study of the Piltdown jaw shows this to be a truly remarkable specimen, and the more it is understood the more valuable it appears as a material proof of man's antiquity.

The jaw is more primitive than any other known jaw relating to early man. It still has a marked sub-mentoneal shelf, in all probability a large canine, and teeth of ancestral pre-human form. It resembles more or less in a number of points the jaws of the chimpanzee, but it differs from these in a whole series of points of importance, such as the form of the notch, type of coronoid process, subdued musculature, markedly reduced internal massiveness of body especially near symphysis; and in the most important characteristics of the teeth, namely, height of crown, height of enamel, nature of "cingulum" and stoutness of cusps—in all of which features it is nearer or like human.

It appears to the author that in view of all this it is no longer possible to regard the jaw as that of a chimpanzee or any other anthropoid ape; but that it is the jaw of either a human precursor or very early man. Dr. Smith Woodward's designation of this form as "Eoanthropus"—a being from the dawn of the human period—seems very appropriate.

An individual, or even genetic, specific, association of the Piltdown jaw with the massive remains of the two Piltdown skulls is, it may be repeated once more, exceedingly difficult of acceptance. The more the lower jaw is studied and understood the less in harmony it appears with the skulls and it is not unlikely that these latter belong to totally different, possibly chronologically much younger, human individuals.

The above may be supplemented with the conclusions which I have arrived at by a detailed comparative study of the Piltdown molars.[1]

The peculiar molars of the Piltdown jaw connect, though in respect to their length and crown index only at the base of the range of variation, with the teeth of man of today.

They connect more closely with the more ancient teeth of early man and may without violence be included among them.

They do not connect with the teeth of any of the living forms of anthropoid apes, though in general these are nearer to them than most man's teeth in the crown index.

In relative, and in one case even in absolute, proportion, they resemble very closely the teeth from the Bohnerz Alb attributed to *Dryopithecus rhenanus,* particularly one of the lower molars; but in morphological details they differ from these, being more human.

The only conclusion that appears justified from these further studies, as from the previous ones, is that the Piltdown teeth, primi-

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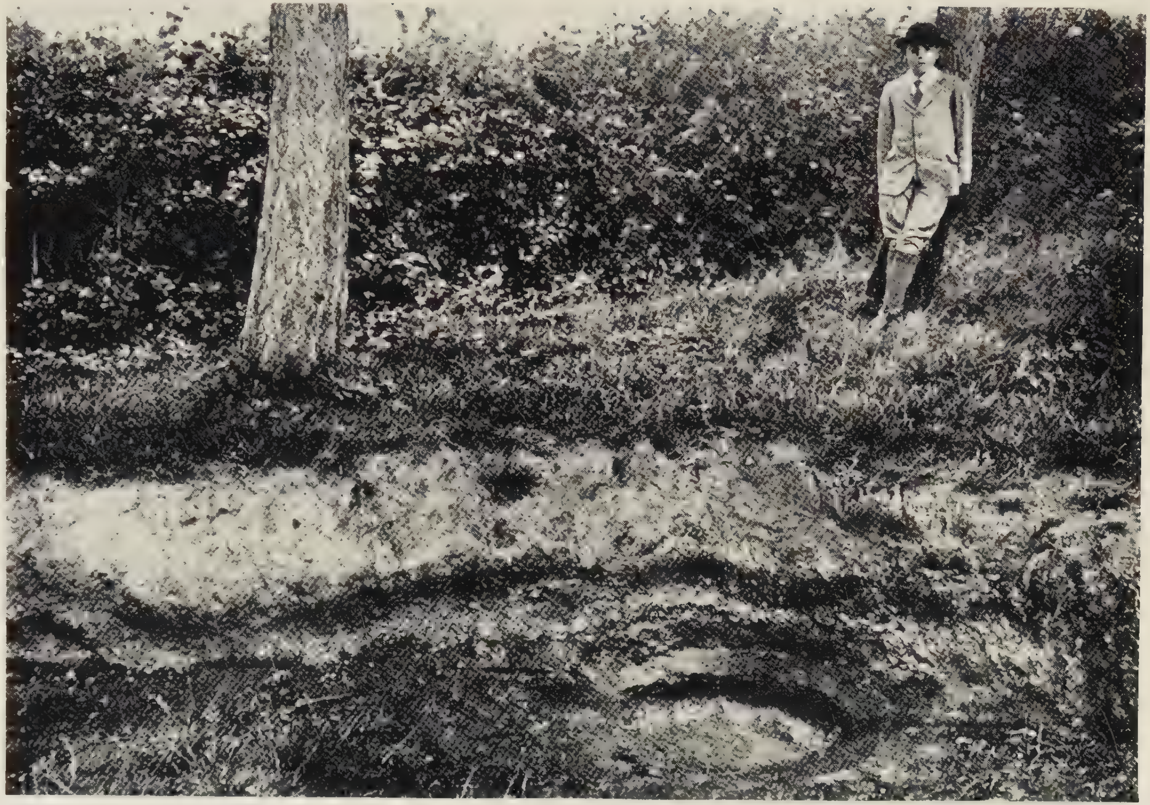
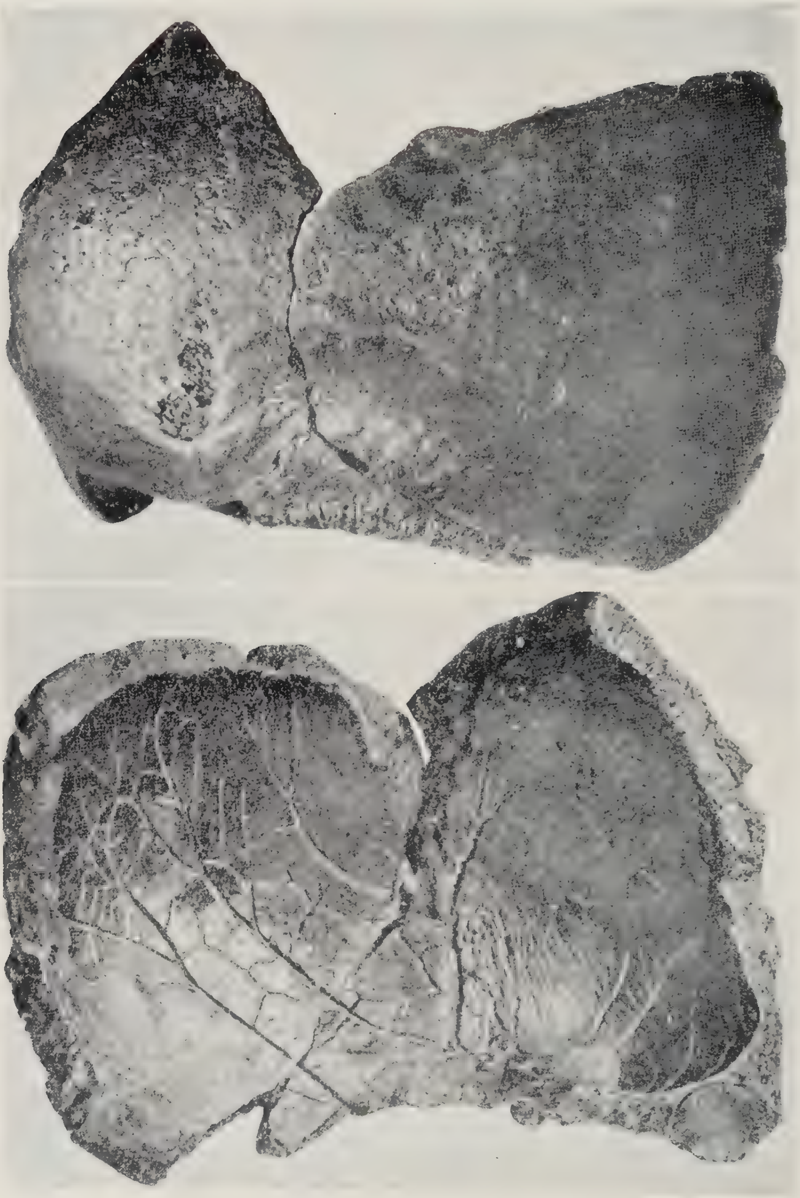
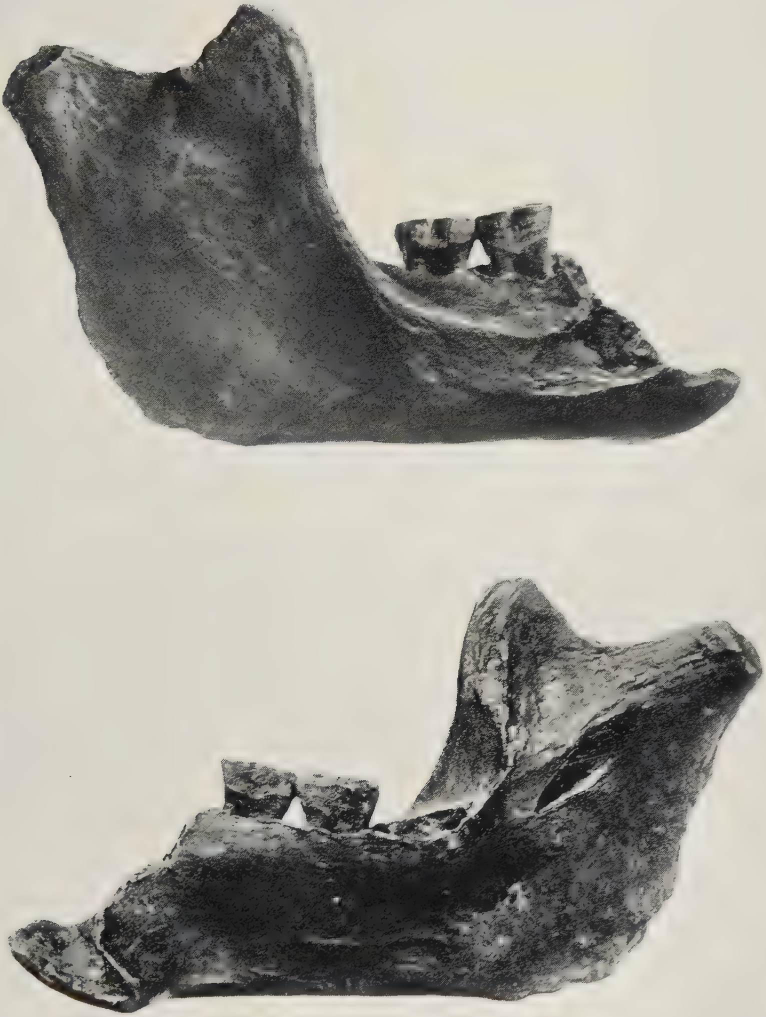
[1] Hrdlička, A., Dimensions of the First and Second Lower Molars with Their Bearing on the Piltdown Jaw and on Man's Phylogeny. Amer. Journ. Phys. Anthrop., Vol. 6, No. 2, p. 216, 1923.



Flint-bearing gravel-bed overlying the Tunbridge Wells Sands (Hastings Beds), at Piltdown, Fletching, Sussex. The darkest stratum resting on the bed-rock in the section is that from which the skull and mandible were obtained. (After Smith Woodward, Quart. Journ. Geol. Soc., Vol. 69, Pl. 15.)



The parts of the frontal and parietal bones of the Piltdown skull (in upper figure, frontal on left, in lower on right). (After Smith Woodward, Guide to the fossil remains of man, Brit. Mus., 3rd ed.)



The Piltdown jaw. (Photograph from the American Museum of Natural History.)

tive ,as they are in some respects, are already human or close to human. Their characteristics indicate that they belong either to a very early man or his very near precursor.

The close relation of the Piltdown molars to some of the late Miocene or early Pliocene human-like teeth of the Bohnerz Alb, as well as to those of the Ehringsdorf jaws, while not conclusive alone, raises legitimately the query as to whether man may not have evolved altogether in western Europe.

THE SEPARATE MOLAR

The additional molar tooth of the Piltdown remains is in every respect so much like the first molar of the Piltdown jaw, that its procedure from the same jaw seems certain, and it would seem probable that the account of its having been discovered at a considerable distance away might be mistaken.

Information as to the discovery of the specimen was, Sir Arthur Smith Woodward informed the writer (Nov., 1927), conveyed to him orally by Dawson some time before the death of the latter. It was to the effect that the tooth was found, together with the two fragments of the second skull, among stones raked off by the farmer from his field. But how could a tooth be found among "the stones raked off the ground and brought together into heaps" (Woodward, Quart. Journ. Geol. Soc., Vol. 73, Pt. 1. p. 3, 1917). What rake would hold a tooth?

The tooth agrees with those of the jaw perfectly not only in dimensions and every morphological character, but also in the degree and kind of wear. If there are slight differences in the wear they are so small as to be insignificant. A duplication of all this in two distinct individuals would be almost impossible.

THE CANINE

The canine tooth, which bears a close resemblance in form to the milk canine of the higher anthropoids, the author is inclined to regard, both on account of the shape of the crown as well as the shape and curvature of the root, as the right lower canine from a female jaw. The wear of the tooth is somewhat peculiar, but not incompatible, it would seem, with this opinion. Taking into consideration the subdued muscularity of the Piltdown jaw, together with the strong indication of the presence of a large canine shown by the basal ridge on the anterior part of the outer surface of the body, it appears probable that the canine may after all have belonged to this specimen.

THE SECOND SKULL

The second skull, found, it will be recalled, two miles away in the rakings of a field, is represented by a fragment of the frontal bone. There is also a portion of the occipital which probably belonged to the same cranium. The find is described in detail by Dr. Woodward in the Quarterly Journal of the Geological Society, Vol. 73, Pt. 1, 1-10, 1917.

The more important fragment is a part from the right supraorbital region and squama of a frontal bone, close to the middle line. Both pieces are similar in color and mineralization to the skull bones of the first find, and are only slightly less thick. The thinnest part of the squama that is left gave Dr. Woodward a thickness of 8 mm., the thinnest part of the frontal squama of the first skull 9 mm.; the greatest thickness of the occipital fragment is 17 mm.; of the occipital of the first skull 20 mm.

The frontal part belongs clearly to a female skull of modern type, and the occipital conforms with this. Though this latter fragment shows more weathering, the characteristics of the two parts are such that their belonging to one skull is very probable.

This second specimen makes it certain that in the Piltdown gravels, within a few feet from the surface, there occur mineralized skulls of almost if not wholly a modern form, though some, at least, are markedly thicker; and with these skulls are loosely associated primitive human implements, and animal fossils of early Pleistocene as well as Pliocene age. The problem is whether the skulls, the implements, and the animal fossils are contemporaneous; in other words, whether the skulls may not somehow be intrusive.

One would like very much to avoid this question; the probabilities seem all to speak for the specimens belonging together; but in view of the history of the deposition of the gravels, together with some of the uncertainties of the find and the apparent incongruity of the parts, the mind is not satisfied.

CONCLUDING CRITICAL REMARKS

The Piltdown remains comprise a series of fragments of two skulls, derived apparently from coarse old gravels.

There are several points of weakness in this connection, on which unfortunately no further light is now possible.

The first is the circumstances of the find. The discovery and removal of the first skull was not supervised by scientific men; there is no information as to exactly how it lay and whether or not there was any noticeable disturbance of the gravel. No amount of trust and benevolence can quite fill these defects of the evidence.

The apparent truth is that the brain part of the first skull was found nearly whole, as the reported "cocoanut" which the laborers broke, and before removal the nasals and a turbinated (one of the spongy bones of the nose) were still plainly with it. Yet neither the skull fragments nor the easily damaged nasals or turbinal show injuries or wear from being rolled in the gravel. Neither are there any gravel marks on the pieces of the second cranium. Here is an enigma which needs, it would seem, some further discussion.

The skulls do not conform morphologically to their apparent antiquity and evolutionary grade. Were it not for their thickness—which experience teaches is an individual, or abnormal, rather than racial character—they could not on their own evidence be separated from modern crania.

The very primitive jaw, with its primitive teeth, does not conform at all to the skulls. It and its teeth are true to its apparent geological age and evolutionary grade, the skulls are not. Its fitting to the skull in the reconstructions may, or may not, be correct.

The similarity of mineralization of the different specimens has seemingly not yet been fully determined. But even if it should be found identical, as is probable, the evidence of it one way or the other could not be conclusive. Mineralization, it hardly needs to be repeated, is a geophysical and geochemical process that is not ever-progressive, but has its shorter or longer time limits; and two or more bones, though introduced into given conditions at widely different times, may nevertheless reach similar degrees of mineralization if the time of inclusion in both cases has been sufficient for the consummation of the changes. This is one of the a, b, c's of natural processes, yet one that very often is forgotten in the presence of remains that show similar color, weight, and mineral alteration. The similar "fossilization" of the Piltdown bones cannot therefore be determinative, one way or the other.

Thus the original main problem, the genetic and chronological association of the jaw and the teeth with the two skulls, remains much as it was soon after their discovery, and no amount of thought, discussion, or even reëxamination of the specimens can promise, it seems, for the present, definite conclusions. The only hope, as in so many other cases in these lines, lies in new and sufficient discoveries.

In view of all this it must be plain that any far-fetched deductions from the Piltdown materials are not justified. This applies particularly to the superficially attractive conclusions that the Piltdown remains demonstrate the existence in the early Pleistocene, long before the Neanderthal and even the Heidelberg forms, of men with practically modern-sized and modern-formed skulls and brains and directly ancestral to *Homo sapiens* or recent man. This hypothesis is a proposition that would change the whole face and trend of human prehistory, and that against all other and better substantiated evidence in this line. Such a theory, all science will agree, could only be established as a fact by the most ample and satisfactory material demonstration, which is quite impossible in the present case.

Work in the Piltdown gravels by Sir Arthur Smith Woodward is progressing; but because of poor financial support the progress is both slow and very limited and has not been crowned so far by any new finds of importance.

ADDITIONAL LITERATURE

The principal original publications on the Piltdown remains have been quoted in the course of the preceding account of the specimens. For the many other contributions see references in the works quoted, especially those in Gerrit S. Miller's papers, including his "The Controversy over Human 'Missing Links,'" Smithsonian Report for 1928.

HOMO HEIDELBERGENSIS

It is a relief, after the clouds of uncertainty that surround in large measure the remains of the Pithecanthropus and those of the Eoanthropus, to turn to a single, normal, clearly authenticated and well defined specimen, the lower jaw of *Homo heidelbergensis*.

The Heidelberg, or more properly Mauer, jaw is one of the oldest relics of early man. This precious document of man's evolution is deposited in the Paleontological Institute of Heidelberg. For its preservation and thorough description we are indebted to Dr. Otto Schoetensack, at that time professor of anthropology at Heidelberg University, who for years had been watching the finds in the sand pits near Mauer which eventually yielded the specimen. But much credit in this connection is due also to Herr Joseph Rösch, of Mauer, the owner of the sand pits in question, who saved the specimen from destruction, immediately called Prof. Schoetensack's attention to its discovery, and eventually donated it unselfishly to science.

The specimen, the lower jaw of an adult male, was discovered accidentally on October 21, 1907, by two laborers. Both these were still employed in the quarry at the time of the writer's first visit to the locality in June, 1912, and they readily related, in company with Mr. Rösch, who kindly had brought him to the quarry, all the circumstances of the find.

The deposits in which the specimen was discovered are located near the village of Mauer, which lies in the picturesque Elsenz Valley, six miles (10 km.) southeast from Heidelberg. They form the moderately elevated undulating northern boundaries of the shallow valley, at a distance of about 2 miles from the present bed of the river, and represent in the main the Quaternary accumulations of the stream. They consist of loess, sand, and gravels, with here and there, in the deeper layers, isolated flat blocks of red sandstone (pl. 15).

The portion of these deposits owned by Mr. Rösch, located about 500 paces north of the Mauer village, have now been worked, in open manner, for upward of 30 years, in which time great quantities of building sand have been removed. During this work, particularly in the lower strata, the workingmen often unearthed fossil shells and fossil bones of various Quaternary animals. Many of these specimens found there way, mostly as gifts of Mr. Rösch, to the Heidelberg University, and the diggings were repeatedly visited by scientific men, among them Prof. Schoetensack. Both the owner and the workmen were enjoined to watch for better preserved specimens, and particularly for anything relating to the presence of man.

On the date of the find, two of the laborers were working in undisturbed material at the base of the exposure, nearly 80 feet in depth from the surface, when one of them suddenly brought out on his shovel part of a massive lower jaw which the implement had struck and cut in two. As the men knew it was worth while to carefully preserve all fossils, the specimen was handled with some care. The missing half was dug out, but the crowns of four of the teeth broken by the shovel were not recovered. The men were struck at once with the remarkable resemblance of the bone to a human lower jaw; but it looked to them too thick and large to be that of man. They called Mr. Rösch and he also was bewildered; but he recognized immediately that the specimen might be of considerable interest to Prof. Schoetensack and so he took charge of it. Returning to the village he telegraphed to the professor, who came the next day, and "once he got hold of the specimen, he would no more let it out of his possession." He took it to Heidelberg, cleaned it, repaired it, and in 1908 published its description in an exemplary way.[1] Since then the valuable specimen has been preserved in the Paleontological Institute of the Heidelberg University, where, thanks to the liberality of those in charge, it is available for examination to men of science.[1]

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[1] Schoetensack, Otto, Der Unterkiefer des Homo heidelbergensis, aus den Sanden von Mauer bei Heidelberg, pp. 1-67, 13 pls., Leipzig, 1908.

Shortly following the discovery of the jaw a most careful examination and study were made of the Mauer deposits. They were found to range from recent accumulations on the surface to Tertiary deposits in the lowest layers. The jaw lay a little less than three feet (0.87 meter) above the floor of the excavation and 79 feet (24.1 meters) from the surface.[2] The same level, as well as some of the higher layers, yielded fossil bones of the *Elephas antiquus, Rhinoceros etruscus, Felis leo fossilis,* and various other extinct species. The age of the human jaw has been determined by these and subsequent explorations to be earlier Quaternary, though there seems to be some uncertainty as yet as to the exact subdivision of the period to which it should be attributed.

The original specimen, when seen, impresses one at once and potently as one of the greatest anthropological treasures. It is a huge lower jaw, which looks simultaneously both human and ape-like (pl. 16).

It presents no abnormality or any diseased condition that could have altered it in shape, so that it may well be regarded as a perfect representative of its type. The bone is dull yellowish-white to reddish in color, with numerous small and large blackish spots. The crowns of the teeth are dirty creamy white, with blackish discolorations on the somewhat worn-off chewing surfaces of the canines and incisors, and a few similar spots over the molars; while all the parts of the teeth beneath the enamel are dull red, as if especially colored. It is much mineralized and feels more like so much limestone than bone. It weighs nearly 7 ounces (197 grams on a letter scale).

The jaw is considerably larger and stouter than any other known human mandible. Its ascending rami are exceedingly broad. Its coronoid processes, thin and sharp in modern man, are thick, dull, broad, and markedly everted. The chin slopes backward as in no human being now known or thus far discovered, with the exception of the Eoanthropus; and there are other primitive features. The total of the characteristics of the bone are such that, had the teeth been lost, it would surely have been regarded as the mandible of some large ape rather than that of any human being.

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[1] The writer wishes to thank herewith especially Prof. Wilhelm Salomon, chief of the Institute, for the courtesies extended.

[2] The exact spot has been marked by Professor Schoetensack with a stone monument bearing the inscription: "Fundstelle des menschlichen Unterkiefers, 21 Oktober, 1907."

The teeth of the Mauer jaw, however, are perfectly preserved, and though large and provided with great roots and in various other ways primitive, they are unquestionably human teeth. They show no crowding, no diastemata. The labial cusp of the anterior premolar was decidedly pointed, the lingual cusp moderate. The teeth force the conclusion that their possessor, while of heavy, protruding face, huge muscles of mastication, wide and thick zygomatic arches, thick skull, probably heavy brows, and possibly not yet quite erect posture, had nevertheless already stepped over that line above which the being could decisively be termed human. His food and his mode of life were related to those of primitive man, and he was already far removed from his primate ancestors with large canines.

The writer will not enter into the minute anatomical details of the specimen, which have been admirably brought out by Prof. Schoetensack, but will give, in a succinct form, his personal observations on the specimens.

THE JAW

The jaw is characterized by a negative chin, sloping very distinctly backward from the vertical.

The total vertical height of the jaw with its teeth, at the symphysis, is 5.2 cm.; in the normal condition of the teeth (without wear) it would be about 5.4 cm. This height alone is not very remarkable and could be matched or even exceeded in jaws of primitive races to-day.[1]

A very peculiar condition is presented by the lower border of the jaw anteriorly. This border is arched in a Cupid's bow, the maximum elevation of which, above the horizontal, reaches 7 mm. on the right and 6 mm. on the left side. Such an arching or "saddle" is not known in any other jaw, ancient or recent. The arching extends to beneath the mental foramina (which are uncommonly large), and passes into a convexity of the lower border so that the corpus is highest at the vertical drawn from the first molar. The height diminishes thence backward in a gentle curve to about the middle of the ascending rami, where it again increases.

Viewed from below, the anterior arched portion of the body of the jaw is not excessively massive, and presents no lingual shelf; but is characterized by a marked bilateral oblong depression for the attachment of the digastric muscles. The oblique line is stout and bulging, and in proper light is seen to extend in a curve to the root of the canine; this is seen especially well on the left side. Lingually the jaw presents a relatively great excess of smooth bone in the anterior and premolar region, the thickness continuing to the molar region uniformly on the left, with some irregularity on the right. The lingual parts of the right molar portion of the jaw, above the mylohyoid ridge, resemble closely some of the hyperostoses or strengthenings found in some modern lower jaws, particularly among the Eskimo.

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[1] Compare writer's "The Anthropology of Florida," Fla. Hist. Soc., Deland, Fla., 1922.

The ascending rami are not very massive but very broad, and show an exceedingly shallow notch, particularly on the left side, which adds much to their unique appearance. The outer surfaces of these rami are markedly hollowed out for muscular attachments, except in their middle portions which are mildly convex. The coronoid processes are relatively stout and markedly everted.

The condyles differ from those of modern jaws by being of greater stoutness antero-posteriorly and lesser breadth laterally. Their articular surface differs also from that of modern jaws, particularly on the left where the central eminence is very marked, so that looked at from the back the condyle has a markedly triangular appearance, the summit of the triangle being dull. The lower and posterior portions of the ascending rami are, curiously, thinner than they are in many strong modern jaws. The lingual mental spines are barely discernible as such; they are represented by a marked rough ridge above which is a fairly large shallow fossa.

THE TEETH

The teeth of the Mauer jaw present numerous points of interest. They are larger than modern teeth, with the exception of some of those found in the more primitive races. They are very regular and show neither crowding nor diastemata. The curve of Spy is slight. The crowns of the teeth show moderate wear. Morphologically the incisors resemble much those of modern man, but are stouter antero-posteriorly. There is no trace of lingual concavity (shovel-shape). The canines stand in just about the same relation to the neighboring teeth, both in size and shape, as they do in modern jaws. They have no lingual cusps.

The anterior premolar, preserved on the right side, has more the appearance of a moderate sized canine with a high labial and a much smaller lingual cusp, than that of an average bicuspid. The crown of the second premolar is more like that in the modern teeth though not entirely similar. The molars had evidently five cusps each. The second molar is the longest and slightly also the broadest of the three. The third molar is well developed.

MEASUREMENTS AND COMPARISONS

MEASUREMENTS OF THE MAUER JAW

	The Mauer Jaw				Modern Male German Jaw	
	Schoetensack		Hrdlička		Hrdlička	
	r.	l.	r.	l.	r.	l.
Whole jaw and corpus:	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Total median length of whole bone (from anterior vertical to middle of base-line of plane formed by applying a plank to posterior borders of the rami)	....		*close to 10.5*		*7.5*	
Length of jaw (from the most anterior point of the alveolar border between the median incisors, to a point at corresponding height on the posterior border of ascending ramus)[1]	....		*12.5*	*12.1*	9.1	9.0
Breadth:						
Bigonial	....		*10.8*		10.0	
Bicoronoid	....		*11.3*		9.8	
Bicondylar	13.04		*13.1*		12.2	
Ramus:						
Height of ascending ramus (vertical, from line connecting uppermost points on coronoids and condyles)	6.63[2]		*6.75*	*6.95*	*6.5*	*6.5*
Breadth min. of ascending ramus	....		*5.15*	*5.05*	*2.8*	*2.7*
Notch, depth max	....		*0.8*	*0.75*	1.5	1.4
Angle	107°		*103°*	*106°*	116°	119
Condyles:						
Transverse diam. max	2.28		*2.25*	*2.25*	2.0	1.95
Antero-post. diam	1.3	1.6[3]	*1.3*	*1.4*	0.9	0.9
Corpus:						
Vertical height in front, jaw and teeth (from horizontal plane on which the jaw reposes naturally)	....		*5.4* *(5.2+.2 for wear of teeth)*		4.5	
Vertical height of bone at symphysis	3.35[4]		*3.5*		3.4	
Vertical height at 1st molar	....		*3.4*	*3.3*	2.9	2.9
Vertical height at 2nd molar	3.18		*3.25*	*3.1*	2.8	2.8
Thickness of body (at right angles to vertical diam. of same) in median line; midway from above	1.75		*1.8*		0.9	

MEASUREMENTS OF THE MAUER JAW—CONTINUED

	The Mauer Jaw				Modern Male German Jaw	
	Schoetensack		Hrdlička		Hrdlička	
	r.	l.	r.	l.	r.	l.
Corpus: (Cont.)	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Thickness, max., in median line	....		*2.5*		1.5	
Opposite Pm 1	....		*1.95*	*2.0*	....	....
Opposite M 1	....		*1.85*	*1.9*	1.45	1.5
Opposite M 2	2.0		*2.05*	*2.08*	1.5	1.55
Opposite M 3	....		*2.25*	*2.25*	1.5	1.5
Thickness, max.	2.35		....	....	....	....
Dental Arch:						
Antero-posterior median diam.	....		*5.85*		5.4	
Breadth max. (externally)	....		*7.05*		6.4	
Index $\left(\frac{L \times 100}{B}\right)$	....		*83.0*		*84.4*	
Combined length of the 3 molars, crowns	....		*3.55*	*3.55*	3.3	3.3

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[1] The right corpus is longer, the left corpus nearly throughout slightly to perceptibly thicker.
[2] Doubtless some difference in method.
[3] Error.
[4] Too small.

MEASUREMENTS OF THE MAUER JAW TEETH (MOLARS)

	M1				M2				M3			
	Schoetensack[1]		Hrdlička[2]		S		H		S		H	
	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Length (antero-posteriorly)	11.6[3]	....	11.2	....	12.7	....	12.8	....	12.2	11.5	12.0	11.5
Breadth (linguo-labially)	11.2	....	11.2	....	12.0	....	12.0	....	10.9	11.3	11.0	11.0
Index	*96.6*	....	*100.0*	....	*94.5*	....	*93.7*	....	*89.3*	*98.3*	*91.7*	*95.7*
Length of the 3 molars as they are in the jaw	Hrdlička: 3.6 cm.											

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[1] Schoetensack, in his Memoir on the jaw, pp. 54–59, gives detailed measurements and details on all the teeth, with the results of X-ray examination. Where his and the present writer's measurements differ slightly the cause must be slight differences in method.

[2] From Hrdlička, A., New Data on the Teeth of Early Man and Certain Fossil Anthropoid Apes. Amer. Journ. Phys. Anthrop., Vol. 7, p. 109 *et seq.*, 1924. Includes comparative measurements by same author and methods on many other teeth of anthropoids, early man, and present races.

[3] Schoetensack's measurement is doubtless the maximum, the writer's that along the median diameter of the tooth.

The differences of the Mauer jaw from that of a recent German are very marked, especially in the antero-posterior dimensions of the whole bone, in its bicoronoid breadth, in the breadth of the ramus, in the depth of the notch, in the angle, in the antero-posterior diameter of the condyles, in the thickness of the body, in the proportions of the dental arch, and in those of the molar teeth.

COMPARISON OF THE DIMENSIONS OF THE MAUER JAW WITH THOSE OF A RECENT JAW OF A STRONG MALE ESKIMO[1]

	Mauer	Eskimo		Mauer	Eskimo
Whole Bone: Median	*cm.*	*cm.*	*Dental Arch:* Median	*cm.*	*cm.*
length	10.5	9.3	length	5.85	5.8
Breadth:			Breadth max., ext.	7.05	6.7
Bigonial	10.8	12.1	Index	*83.0*	*86.6*
Bicoronoid	11.3	9.9	*Teeth:* Length of the 3		
Bicondylar	13.1	12.8	molars in position	3.6	3.5
Corpus: Length, mean	12.3	11.3	Relative Sizes	M2	M1
Ramus:				M1	M2
Height, mean	6.85	7.1		M3	M3
Breadth min., mean	5.1	4.95	M1, labiolingual	*mm.*	*mm.*
Notch, depth max.	0.8	1.2	diam.	11.2	12.5
Angle	105°	118°	M2, length	12.8	12.0
Condyles: Transverse			breadth	12.0	12.3
diam.	2.25	2.45	index	*93.7*	*102.5*
Antero-post. diam.	1.35	1.25			
Corpus:					
Height less teeth at					
symphysis	3.5	4.5			
at M1	3.35	3.95			
at M2	3.17	3.65			
Thickness max. at					
symphysis	2.5	2.0			
at M1	1.87	1.8			
at M2	2.07	1.85			

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[1] No. 339,064, U. S. Nat. Mus.; from Tanunuk, Nelson Island, Western Alaska; collected 1927 by Collins and Stewart.

An even more interesting comparison perhaps will be that of the Mauer jaw with a recent powerfully developed jaw of an Eskimo the ascending rami of which, both in their breadth and form, approach considerably those of the fossil bone. The measurements are given in the above table.

Notwithstanding the approach of the Eskimo to the Mauer jaw in various respects it is seen nevertheless that the fossil specimen still exceeds the recent one in total length in the bicoronoid and bicondylar breadth, in the antero-posterior diameter of the condyles, in the shallowness of the notch, in the thickness of the jaw, and in the breadth of the dental arch. The Eskimo jaw equals or nearly equals the Mauer mandible in the breadth of the ramus, in thickness at the first molar, in the median length of the dental arch, and in the combined length of the three molars. The Eskimo jaw exceeds the Mauer specimen in the bigonial breadth, in the height of the ramus, in the angle (more oblique), in the breadth of the condyles, in the depth of the notch, and in the height of the corpus throughout its extent. The teeth of the Eskimo jaw, while large, have nothing of the primitive characteristics of those in the fossil specimen.

Schoetensack has compared the Mauer specimen with all other fossil human jaws known up to 1908, the date of the publication of his Memoir. He found it to be more primitive on the whole than any other of these specimens and to represent more ancestral conditions.

CONCLUDING REMARKS

The carefulness of the workmen in the Mauer sand deposits has been redoubled since the find of the jaw, and the locality has also been subjected to considerable scientific attention, but thus far without further important result so far as human remains are concerned. The specimen found in 1907 became evidently mingled accidentally, and while still fairly fresh, with the ancient alluvia, wherein by rare good fortune it was perfectly preserved. Its eventual location was apparently not near a site of the man it represents, for the Mauer sands and gravels have so far yielded no human artifacts. There can be but little hope that other parts of the same skull or skeleton will ever be recovered; but it is not impossible that the large early accumulations of the Elsenz Valley may inclose and some day yield parts of some equally early individual which will throw further light on the physical organization of this most interesting ancient representative of humankind.

THE RHODESIAN MAN[1]

On June 17, 1921, a very remarkable human skull was discovered in the Broken Hill Mine, Northern Rhodesia. It was the skull of a man whose features were in many ways so primitive that nothing quite like it had been seen before; and coming from a part of the world which hitherto had given nothing similar and in which nothing of that nature was ever suspected, it aroused much scientific attention.

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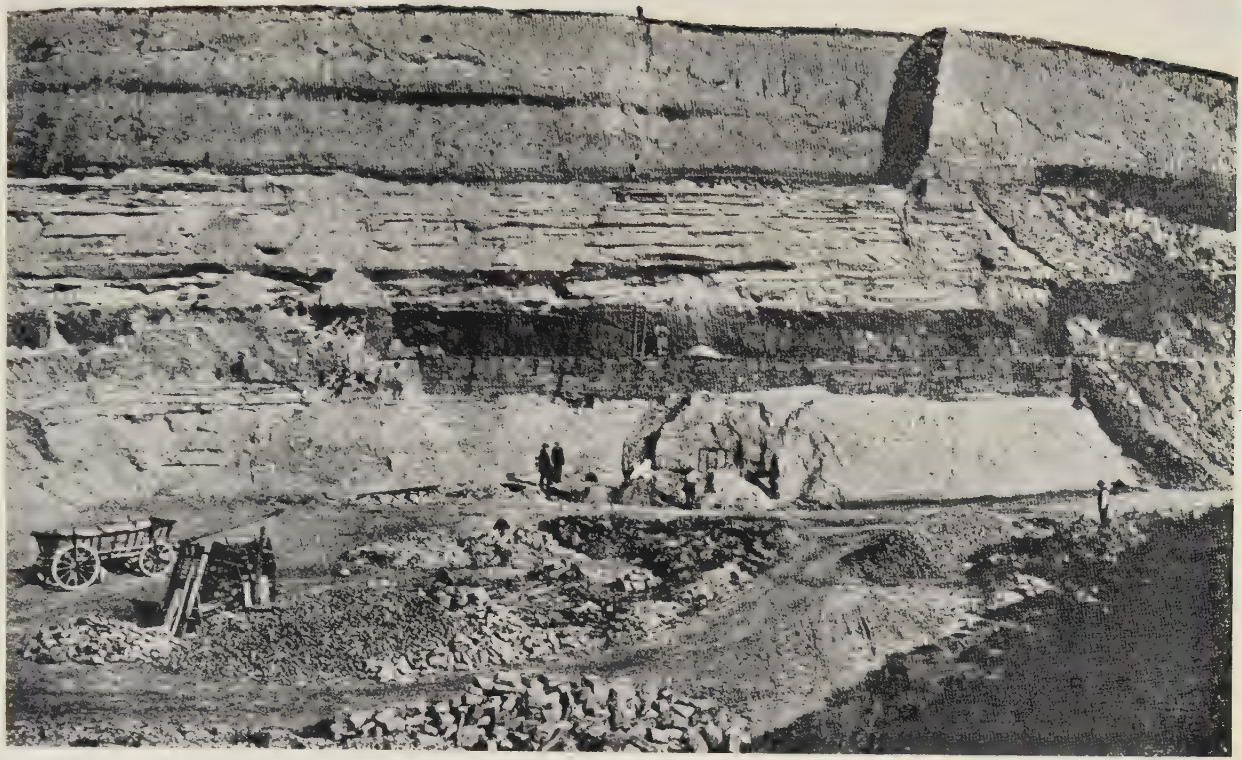
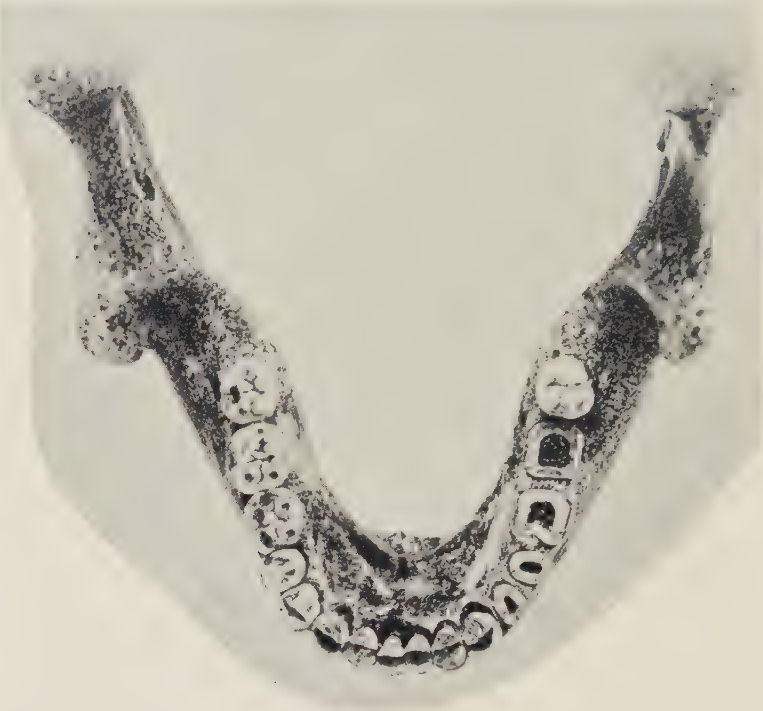
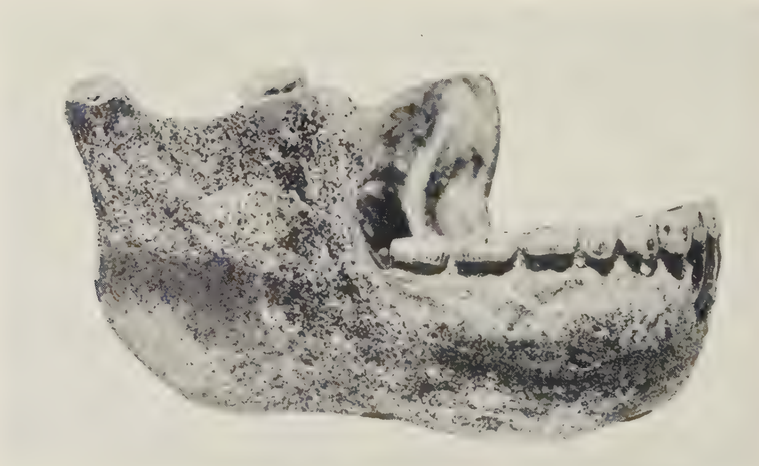
[1] This section represents a part of the results of the author's Smithsonian-Buffalo Society of Natural Sciences Expedition, 1925.



The Mauer quarry. The spot where the lower jaw was discovered is marked by a white cross.
(After Schoetensack.)



1. The Mauer jaw. (After Schoetensack.)



2. The Mauer jaw. (After Schoetensack.)

Fortunately the specimen was saved with but minor damage, and later in the same year was brought by the manager of the mine to the British Museum (Natural History) where, safely preserved, it constitutes one of the scientific treasures of that Institution.

CIRCUMSTANCES OF THE FIND

The detailed circumstances of the find were, however, not as fully and definitely established from the start as would have been desirable. The specimen was found and taken out by a miner; there was no scientific man on the spot, and the wonder is that so much was saved. The whole occurrence is to the lasting credit of all concerned.

The lack of precise information on certain important points was soon felt by the students of the subject; and it now seems that even what was known at first suffered some subsequent confusion. The sparse data about the Rhodesian find left a desire for more details regarding the position of the skull, its surroundings, the cave itself and its fillings, the nature of the animal bones in the cave, the general region in which the " broken hill " with its cave existed, and possible other remains, as well as the native types of the territory. The skull was so remarkable that every view of it and every further word published upon it served only to intensify the feeling of need for more complete information on the above points. It was this motive, together with the recent discovery of the skull of a highly interesting anthropoid ape near Taungs, Bechuanaland, that induced the writer to extend his late journey to South Africa.

The success of his visit to Northern Rhodesia was due largely to the aid of Professor Dart of Johannesburg, and to the fine men in charge of the " Rhodesia Broken Hill Development Company." Of the latter particular thanks are due to Messrs. Ross K. Macartney, the General Manager; George W. Rudyerd, Assistant General Manager; W. E. Barron, former Captain of the Mine; and G. Chad Norris, Engineer. But there were many other helping hands, including Dr. Wallace, Messrs. Jolly, Swigelaar, Hayward, and still others, whose assistance is hereby gratefully acknowledged. The efficient and high-minded officials of the mine deserve the thanks of the whole scientific world, for it was due only to them that the Rhodesian skull was preserved and brought in safety to the British Museum. These gentlemen extended to the writer every facility. They would doubtless do this to any other qualified student, and they will henceforth watch keenly for all further discoveries on the site and in the vicinity.

Upon his arrival at Broken Hill the writer was rather astonished to find the whole region for many miles in every direction to be a great, loosely forested plateau, perfectly level except for a small "kopje" situated near the railway tracks as one nears the Broken Hill mine and settlement. This little hill, only about 90 feet high, is said to resemble closely the former "broken" hill which gave us the Rhodesian man and which has now been removed through mining operations.[1]

The plateau of the town of Broken Hill is 3,874 feet above sea level. Up to the time of the commencement of mining operations it was a part of a vast, featureless, more or less openly forested region. But the minerals in the two kopjes—lead and zinc—may have been known to the natives in earlier times. At all events, in digging ditches and in other surface excavations about the mines and in the town, there are being found, buried as deep as 8 feet below the present surface, old primitive native smelters, with here and there some negro pottery indicating probably former burials. Mr. J. H. Hayward in charge of the surface works, has found such an old primitive, probably negro smelter under the roots of a big tree, and he led the writer to a ditch where 6 to 8 feet below the surface were seen *in situ* large fragments of thick black native pottery. There evidently existed here at one time a native settlement, the men of which worked some ore. The smelters may, however, have been used for iron or other metal than those found in the two small local hills.

The "broken" kopje consisted of hard dolomitic limestone impregnated with lead, zinc salts, and vanadium. It was originally full of crevices and holes, and had, as shown in the course of mining, at least two large caves leading deep into the interior. The cave of special interest became known as the bone cave. In the course of time it had become filled with sand, soil, bones of animals, and detritus of various kinds, which in turn were impregnated by seepage carrying in solution mineral salts and lime. The salts formed incrustations on the walls, here and there new ore deposits, and in general consolidated most of the contents, bones included, into "pay ore."

The kopje that yielded the "Rhodesian skull" was situated approximately northwest to west of the present railroad station, and was about 50 feet high by 250 feet in its longer diameter. This entire elevation has now disappeared and where once was a hill is now a deep hole, in and about which mining operations are still energetically conducted (1925).

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[1] In one of the accounts to be quoted later mention is made of several such small hills, but only one and the remains of the one that gave the skull were seen by the writer.

Mining by white men is said to have begun at Broken Hill in 1895. Information about these times is hazy. The tradition is that the "broken hill" before mining looked much like the kopje now remaining; that its weathered and irregular surface was, as already said, honey-combed with holes and crevices; but that apparently none of the openings led to the great cave filled with bones, débris, and ore, which in 1921 gave the Rhodesian man.

The main part of the bone cave appears to have been entered by the miners accidentally in the course of their operations; it was partly excavated and found to contain large quantities of more or less mineralized animal bones, with some stone implements. Of this occurrence there are reliable records.[1] The initial notes on the subject are of such value, and at least one of the reports is so difficult to find, that the relevant parts are reproduced in full at the end of this section.

So much for the earlier information about the Broken Hill cave, and nothing further appears to have been said in print about it until the latter part of 1921, when the Bulawayo and other South African papers brought news about the discovery of the "Rhodesian skull."

These earlier reports of which the writer saw copies at the office of the Broken Hill Development Company, are of the usual newspaper style and, beyond signalling the discovery, give little of value. The first more detailed notices of the find appeared on November 8, 9, 10, and 11, 1921, in the London "Times." Shortly after that, on November 17, the first brief scientific report of the find was published in "Nature" by Dr. A. Smith Woodward; and on November 19, a comprehensive and gorgeously illustrated report by W. E. Harris,[2] as well as a description of the skull itself by Sir Arthur Keith, was carried by the "Illustrated London News," with the addition of an ingenious restoration of the race of men represented by the specimen.

Four years (1925) have elapsed since then. In their course at least eight further brief scientific contributions on the subject of the "Rhodesian Man" have seen light. And the skull, with the type and age of the human form to which it belonged, remains still largely a puzzle. Moreover, errors of a serious nature have crept into the accounts of the circumstances of the discovery, and these have already materially affected important conclusions.

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[1] Mennell, F. P., and Chubb, E. C., On an African Occurrence of Fossil Mammalia Associated with Stone Implements. Geol. Mag., n. s., Decade V, Vol. 4, p. 444 *et seq.,* Jan.–Dec., 1907. See Appendix I.

[2] See Appendix II.

What one learns definitely from the early notices of Broken Hill, by one of the chief officials of the mine (Engineer Franklin White), is that about 1907 the bone cave was found accidentally in tunneling operations; that it was not known to have any outward opening; that it was nearly filled with large quantities—many tons—of more or less mineralized bones, clay, débris, and ore; and that with the bones were fairly numerous quartz and chert implements, resembling in general those of Bushmen and perhaps other African natives of protohistoric and prehistoric times.

Some of the implements and bones were saved through the instrumentality of Mr. White and donated to the Bulawayo Museum. They were later studied by Mennell and Chubb. Still later the bones came to the British Museum and were examined by Andrews. They were diagnosed, with one probable exception, as belonging to recent forms of Rhodesian mammals. There were no human bones in the collection. The archeological objects were noted but the find was not followed up.

Then came the accidental great discovery of 1921. Again there was no scientific expert on the spot and none came after. The details were not noted in writing. The news circulated in the South African papers, but there was no authoritative account; the reports differed among themselves and included inaccuracies.

Five months after the discovery, the skull and a number of human as well as other bones were brought to England by Mr. Macartney, the manager of the mine, and were generously donated by the company to the British Museum (Natural History). No written statemen accompanied the donation. But from the oral account of Mr. Macartney, and above all from the good illustrated article by William E. Harris, an official of the mine, in " The Illustrated London News," November 19, 1921, there became established a notion of the details of the find which was gradually adopted by all writers on the skull and which is responsible for serious uncertainties. Above all it became an accepted idea that several human bones brought to England with the skull were found with the cranium and belong to the same individual or the same people, and from the characteristics of these bones deductions were made as to the morphological and even chronological status of the Rhodesian man. Some measurements of the skull and bones were published, also a few observations and thoughts on the endocranial cast which represents the brain; a tacit expectation was reached that a complete report on the case was being prepared by Doctor Smith Woodward; and active interest was gradually transferred to new discoveries.

These were the data and such was the state of affairs when the opportunity to visit the Broken Hill locality came to the writer during the summer of 1925.

THE WRITER'S INVESTIGATION IN 1925

With the utmost cooperation of the officials of the mine, and in fact, of every one approached, the first task was to learn on the spot as much as possible of the history of the 1921 discovery. This unexpectedly proved no easy matter, owing to the scarcity of old employees, but especially to the uncertainties of memory of those who had been present at that time. The following nevertheless appeared to be the consensus of the recollections:

Before mining began in this craggy "broken" kopje there was nothing to indicate the presence of any human habitations about the hill. If there was anything it was not conspicuous and escaped notice.

Mining was carried on from a side, but due to the conditions of the mineral deposits, work was later commenced also from the top, proceeding downwards. During the earlier operations from the side, a good-sized cave or fissure was reached and found to contain dirt, ores, and numerous bones. The bones were those of animals; if any others were present they were not noticed. They were mostly so mineralized that they were in the main smelted with the rest of the ore, and after the first impressions received little further attention.

When the excavations from the top reached in the center to approximately 90 feet below the surface of the ground surrounding the kopje, a large inclined plane was opened to the central funnel from near the side at which the original work began. At some distance this plane once more encountered the large bone crevice that had been discovered before. The crevice here passed obliquely across part of the incline, and, as in the portion seen earlier, was filled with detritus, bones of bats or rodents, ore, and more or less mineralized bones of larger animals. The extent and contents of this cave or crevice were only learned gradually in the course of the prolonged work of mining.

After the inclined plane reached the bottom of the central excavation, some of the workmen were directed to turn back and work on the ore and stone exposed by the plane; and it was in these parts, not long after, at a level of approximately 60 feet below the surface, that a Swiss miner, Mr. T. Zwigelaar, working with his black "boy" in some softer fillings, was confronted after a stroke of the boy's pick with the Rhodesian skull.

It is to the lasting credit of this miner that the specimen was carefully taken out, saved, brought to the attention of his superiors, and reached the right hands. These hands, at the advice of the manager of the mine, were those of the company physician, Dr. A. F. Wallace, and he safeguarded the specimen for three weeks in his office. It was then taken in charge by the manager, Mr. Macartney, to be later in the year personally transported by Mr. Macartney to the British Museum. There was much more to the story than here expressed, and some of the details were stated differently by different persons, but the above appear to be the simple essentials.

After learning the generalities and being shown over the mine by Mr. Rudyerd, the writer endeavored to reach personally every man concerned with the find or on the spot at that time, who might still be found at Broken Hill or reached through the mails, in order to obtain from each one independently as detailed and circumstantial information about the discovery as it might still be possible to get. As only four years had elapsed since the time of the find, it was hoped that a number of the men who were concerned with it would still be found on the spot and that their memories of the find would still be quite clear and reliable.

As good fortune would have it, before the writer's departure from Broken Hill he was able to locate and interview five of the men concerned from the beginning in the discovery, including Mr. Zwigelaar who actually found the skull; and a sixth one was reached later by a letter. Each of these men was most willing to tell all he knew; but their memories regrettably were no longer clear as to the particulars. However, what was obtained is not without importance.

The most noteworthy information is that of the discoverer of the specimen, Mr. Zwigelaar. He was found to be a serious middle-aged man, not highly educated but of good common sense, and he tried hard to give the main facts of the find as he remembered them. The gist of his statements, repeated and reasserted, follows:

> It was about 10 a. m. one day. We were working back from the incline at its lower part. I had a colored boy (young man) with me and we were "hand picking" in a pocket where there was much lead ore. The digging was not hard, not like stone, more loose. After one of the strokes of the pick some of the stuff fell off, and there was the skull looking at me. It was very strange and with some of the matter adhering to it looked so unlike an ordinary human skull that I thought it was a big gorilla. I took it out carefully, showed it to the officials of the mine and others, and later that day brought it in to Mr. Macartney who in turn sent it to Dr. Wallace. Soon after the find was made Mr. Macartney

(I believe) took a photograph of me holding the skull against the place where it came from (pl. 18),[1] and other photographs were taken also.

The skull was at some depth under the pure lead ore and, as far as I can recall, about 10 feet below what seemed to be the floor of the bone cave further away. Where we were then I could see no connection between the material about the skull or the pocket it was in and the bone cave, though it may have been [and later was shown to be] the same old crevice. They were separated by the lead ore and the stuff in which the skull lay. That ore was very rich; it was not hard though necessitating the use of a pick. There was much of it further in and above.

There were no other bones close to or near the skull, and no other objects that aroused attention. But a little later and not far below the skull we came on a sort of a bundle which looked like a flattened roll of hide standing nearly upright; the "hide" was thick and was of ore; it showed no remains of a real hide but looked somewhat like it. Pieces of it were removed and shown about, the rest was smelted. There was nothing within the "roll"—no bones nor any other object.

The skull was surrounded by softer stuff. There was something like bat bones. There were hard and soft spots in the digging. Next day we looked for the lower jaw but nothing was found.

Some time afterwards, but on the same day, we found outside of where the bundle was and to one side of it, about three feet away as near as I can remember, the leg bone of a man. There were no other bones. Later and lower was found a skull said to be that of a lion; but that was not found by me.

The skull was taken first to the manager's office and from there to the doctor's. That's all I know.

So much for Mr. Zwigelaar. On repeated questioning, his account remained the same. He was positive the skull was alone, without the lower jaw and without any other bones in association. He also was positive that there was no covering of the skull and that the "roll" lay lower and not in connection with the specimen. Directly behind the skull were some bat bones.

The next most important person still present at Broken Hill was the mining captain at the time of the discovery of the skull, Mr. W. E. Barron. Mr. Barron was found at the site of the new dam and power tunnel about 20 miles from Broken Hill, and was brought back to the mine. Unfortunately his recollections of the details of the discovery were already hazy. However he produced an old note book in which he had written, shortly after the find was made (a day or two later) the following valuable notes:

"Old Bone Cave: Skull found at side of incline about 60 feet level, by Zwigelaar, 17-6-21. A mass of small bones (probably bat bones) all around it.

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[1] This precious and unique photograph was loaned by Mr. Zwigelaar to the writer and is here reproduced.

"In afternoon of same day big portions of animal skull with teeth in good condition (apparently lion) found in same place (speaking generally) by Angelo."

All other information regarding this lion's skull is to the effect that it was found at some distance away from the skull, possibly as much as 8 or 10 feet, and at a considerably lower level. It was impossible to ascertain conclusively what had become of this specimen. There is a somewhat mineralized lion's skull, proceeding doubtless from some part of the bone cave, in Mr. Macartney's office and it may be the specimen in question; or it may have been forwarded to the British Museum.

Mr. Barron assured the writer also that in the same digging there was found an artificially made quartz ball about 3 or a little over 3 inches in diameter (size of a fist). Zwigelaar upon re-interrogation in the presence of Mr. Barron was sure that there were no bones whatever, human or animal, near the human skull except the bat bones; neither could he remember anything about the stone ball. A stone ball answering to the description was later brought to the writer with a statement that it came from somewhere in the end part of the crevice, and was taken by him with other objects to the Museum at South Kensington. However, other similar balls from the cave had also been taken to the Museum with the skull in 1921 (see page 122).

Mr. Barron's name in the English records of the find is given as "Barren," and as in the same records he is reported as the discoverer of the skull, the writer asked him for a written statement on both points. The result was the following letter which settles both questions:

MULUNGUSHI, R. B. H. D. CO. LTD.
BROKEN HILL, N. RHODESIA
12TH DEC., 1925

DEAR MR. HRDLIČKA:

I was very glad to get your letter. I have come across the correspondence of December, 1921, which I mentioned to you, and, as it has bearing on the whole matter connected with the skull I am enclosing it all for your perusal. The copy of my letter to Mr. Moffat I have just made from a pencilling I had with the others.

It was Zwigelaar and his boy who saw the skull *in situ* and extracted it, and Zwigelaar brought it to my office. I was Mine Captain in charge of mining operations.

The collar bone and the case referred to in my letter to Mr. Moffat were certainly in the close vicinity of the skull, and we attributed them to the same skeleton at the time, the casting being taken for the fossilised remains of the skin he was wearing. . . . .

With kindest regards,

Yours sincerely,
(Signed) W. E. BARRON.

The "December 1921 letter to Mr. Moffat" referred to above, reads as follows:

DEAR MR. MOFFAT:

I got your letter about the skull.

The following is from my note book: "Old Bone Cave: Skull (which might be either man or monkey) found East side of Incline about 60 ft. level by T. Zwigelaar 17-6-1921.

"A mass of small bones (probably bat bones) all around it.

"In afternoon of same day big portion of skull with teeth in good condition (apparently lion) found in same place by Angelo. Block P 7."

I gave the above in my report, either fortnightly or monthly, of the period, which could be obtained from the Mine office in Broken Hill.

A spherical stone implement, a collar bone[1] and a lot of casting (fossilised skin or matting) were found practically in the same place.

I have brought away with me none whatsoever of the bones or implements.

The skull, and a number of other fossilised bones which Dr. Wallace (of Broken Hill) considered of special interest,[2] were packed in a box for Mr. Macartney to take to London with him.

There was quite an interesting lot of bones shelved in the office and the tool hut at the mine when I left. Mr. Macfarlane, my assistant, who took over from me, will know of them.[3]

One huge bone which appeared to be the thigh of an elephant or something of that kind, Mr. Macfarlane should have no difficulty in sorting out from the tool hut; an assay of a portion of it gave about 8 per cent Pb. and 4 per cent Zn; it was got from about the 40 ft. level many months ago. Another of special interest is in the Survey Office behind the Engineer's Office; it has the appearance of having been an elephant's hip bone or something of that sort, also from about 40 ft. level.

As the skull which is attracting so much attention was got from the East side of the incline at about 60 ft. level, and a great deal of bone débris is probably still intact in the incline itself, things should be watched with great interest when the time comes for mining away of the incline when hoisting commences at No. 2 shaft.

Yours faithfully,
(Signed) W. E. BARRON.

Another old employee, who was present at the time of the discovery of the "Rhodesian Man" and who saw the specimen shortly after it was discovered, could give no details of value. The importance of the find was not appreciated, no special effort was made to go into details, and the incident passed out of memory.

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[1] No such bone was remembered by Zwigelaar, and no such specimen is in the British Museum (Natural History).

[2] This phrase deserves close attention. There is no intimation that these bones were associated with the skull.

[3] This is doubtless one of the lots of bones found by the writer; see later.

The manager of the mine, Mr. Macartney, remembers clearly the main items relating to the find. He saw the skull shortly after discovery and he also saw the place where it was found. He feels certain that the softer spot in which the skull lay contained quantities of detritus with bats' bones. He also remembers a thick layer (about 30 feet) of very pure and not very solid lead ore that lay between that part of the crevice or cave that contained the skull and the bulk of the cavity which was filled with more or less mineralized animal bones, detritus, etc. There is uncertainty as to a possible connection of the contents of the two portions of the cave under the ore.

Dr. Wallace very kindly gave the writer a written account of his recollections. They are as follows:

> I only heard about the skull about two weeks after it was found. It was then at the Mine office, and the General Manager, Mr. Macartney, sent it down to my surgery where I had it for three weeks. I am quite sure that the lower jaw was never found. The skull was sent to me with a few other bones in a box. Amongst these bones was what might have been a human tibia. I did not recognize any of the other bones as being of human origin.[1]
>
> Mr. Armstrong, who at the time was the metallurgist here, took a great interest in the skull. It was he who first told me about it. I think that among the bones sent with the skull were two pieces of what Mr. Armstrong thought was some fossilized material that had been wrapped round the body. Mr. Armstrong's idea was that this had been an animal's skin. I think Mr. Armstrong has a piece of this in his possession but I am not sure.
>
> One of the teeth in the skull was loose and could be lifted out. When I sent the skull and the other bones back to the Mine Office I sent the tooth with them.

The writer then wrote to Mr. Armstrong, who meanwhile had moved to Australia, and received from him the following notes:[2]

> SYDNEY, 21ST DECEMBER, 1925
>
> DEAR MR. HRDLIČKA:
>
> I was extremely pleased to hear from Dr. Wallace of your visit to Broken Hill, and much regret that I was not there. . . . . I was informed of the find a few minutes after the skull had been unearthed, and immediately went to the mine and collected all the bones exposed in the immediate vicinity.[3] The bones which were eventually taken to Kensington Museum proved to be (1) part of a human lower [upper] jaw; (2) a human leg bone; (3) a lion's skull.
>
> At the time of the discovery I was in charge of the Works only and had no authority at the Mine. . . . . No systematic search was made for further important bones and the skull with the bones I had collected was left in the Mines Shelter Office.

---

[1] This is an important statement, made by one well acquainted with human bones.

[2] Certain personal references omitted.

[3] Statements plainly somewhat erroneous.

In 1922 I left Broken Hill and came to Australia. At the request of Professor Burkitt I called at the Sydney University and gave him particulars of the find. I left the sample to which you refer with him. It was not a bundle (I know nothing of any bundle being found) ; it was part of a protective covering which completely encased the skull.[1] This had been broken off before I arrived at the mine. The importance I place on this is due to the fact that none of the other bones in the vicinity had any such covering.

In August, 1922, I went to London and called upon Professor Woodward at the Kensington Museum. He showed me the skull and the various bones which had been delivered to him by Mr. Macartney and I recognized the ones which he stated were the lower [upper] jaw, and the leg bone and the lion's skull—these were all discovered within a foot of the skull.[2]

I know little of anthropology, but from the geological point of view and from close observation of the so-called "cave" in which the skull was found, I consider there is proof of a much greater age than the estimate given by Woodward.

Yours truly,
(Signed) A. S. Armstrong.

The foregoing documents make it only too evident that the exact details of the rare find were recorded by no one; and that the remembrance of them has in the course of time become more or less confused even in those who were on the spot soon after the discovery. The statement of Mr. Harris in "The Illustrated London News" (see Appendix) made five months after the event is doubtless no less faithful but also no less defective than the others.

Hoping that something more precise might have been given to the British Museum (Natural History), the writer turned to Dr. Bather, the present Keeper at that Museum of the Department of Geology and Palaeontology, and was very kindly furnished with copies of all the official entries relating to the find and an earlier collection from the same cave. They read as follows:

November 15, 1921 — Franklin White, Esq.,
3379 — 11a Harrington Gardens, S. W. 7.

Four stone implements and three pieces of worked bone collected by the donor in a cavern in the Broken Hill Mine, N. W. Rhodesia.

November 24, 1921 — The Directors of the Rhodesia Broken Hill
3382 — Development Company, Ltd.,
(per Edmund Davis, Esq., Chairman),
19 St. Swithin's Lane, E. C. 4.

A primitive human skull, with part of maxilla of a second skull, a sacrum, three pieces of femora, and a tibia; also seven associated bones of mammals, and two round pounding stones; found in a cavern at the Broken Hill Mine, N. W. Rhodesia.

---

[1] Statements plainly somewhat erroneous.

[2] Error.

May 8, 1922
3438

Franklin White, Esq.,
19 St. Swithin's Lane, E. C. 4.

Collection of stone implements from Broken Hill cave and other localities in South Africa.

As the collective sifted result of the information obtained from all quarters, with the results of the personal inspection of the mine and of what remained of the bone cave, and with the impressions left by the different men associated with the finds, the conclusion is that the real conditions had probably been somewhat as follows:

The "bone cave" was an extensive irregular crevice running for 120-150 feet inward and downward from near the outer base of the hill and reaching the maximum depth below the surface of about 70 feet.

There is no recollection of the mouth of the "cave" and this may have been covered or obstructed. Inside, the crevice enlarged to a cavern which at its maximum measured probably over 30 feet in breadth and twice as much in height.

For some distance from the mouth of the cavern the floor of the latter was nearly level or but moderately inclined, then there was a steeper descending slope, and after that the crevice ran irregularly downward and inward.

The outer part of the cavern was largely filled with more or less mineralized and consolidated bones of animals, cave detritus, large quantities of bones of bats or small rodents and nondescript earthy material, the walls being covered with crystals of the ores of zinc and vanadium. The larger bones were distributed unequally through the filling of the cave, in some places there being large quantities of them, in others few or none. They extended to and beyond the descent in the floor.

The lowest and innermost part of the cavern was filled by detritus, some bones, and a considerable layer or rather layers of very pure and more or less crumbly lead ore. The ore contained no bones or foreign substance; but it is not absolutely known whether the contents of the distal part of the cavern had a direct connection with the materials in the large outer portion through or underneath this lead ore.

The skull was found at some distance beneath a layer of this ore, which was according to Mr. Zwigelaar's recollection, about 10 feet thick. It was not itself embedded in the ore, but in a detrital material not mineralized to any extent, and containing a quantity of "bat" bones.

The skull was an isolated object. It lay upright. There was no lower jaw, nor any other bone in apposition. Beneath it, at some distance, was what looked like a large flattened skin bundle, thoroughly mineralized. This was probably a natural laminar formation of the lead ore. Barring a few fragments it was smelted.

Somewhere in the vicinity of the lower portion of this "bundle" was found a remarkably straight, but otherwise not peculiar, full-sized male human tibia, and lower at some distance were portions of a mineralized lion's skull. In the vicinity there may have been found also some other human fragments, but here much is uncertain.

The larger part of the bone contents of the main part of the cave were so mineralized that they passed for a good grade of zinc ore and were smelted as such. Various portions of the cave fillings, however, were poorer and were brought out and thrown on a dump where, covered by poor rock and débris thrown out subsequently, they still repose. The ground and débris in the dump are still full of fragments and pieces of bone, with teeth, chips of quartz, etc.

Only traces of the great cave now remain in the mine, and as the work progresses they will disappear. The opposite wall of the mine shows an even larger old cavern, completely filled with less consolidated and somewhat darker materials than the surrounding rock. This cave has given no bones.

ADDITIONAL MATERIAL

While gathering this information the writer learned casually that some of the loose bones from the bone cave—exact parts unknown—were saved and might possibly still be found in some of the offices and tool huts of the mine. Accordingly as soon as possible a search was instituted in company with Mr. Rudyerd, and before long several lots of such bones were located in the main office, in the designer's room, in another small office, and in two small huts near the mine. Those in the main office were in a case with a series of mineral specimens from the mine, and represented especially bones enclosed in mineral matrix; the bones in the other places were loose and not encrusted, only more or less covered with earth and dust. All the bones, however, showed more or less mineralization.

In addition the officials of the Company very kindly gave the services of two "boys," with whose help digging was begun into the old dump, with the result that in two days numerous additional bones and teeth were added to those already located. All this material was then washed, dried, spread out on a large designer's table and sorted.

Even before this, however, while handling the dusty bones in the designer's office and in the tool house, the writer had found among them in the former place a large portion of the distal end of a human humerus, and in the hut a piece of a human parietal. Both of these specimens showed the same mineralization as the rest of the numerous bones and were plainly parts of the same lots. As there is not the slightest intimation that these many scores of animal bones, some of them very conspicuous, were found anywhere near the Rhodesian skull, they probably all proceed from other parts of the cave; and as the human bones among them were of the same color and mineralization, there is a strong probability that they were with these bones where they lay. Which means that human bones were found also elsewhere in the crevice, a fact having an important bearing on some at least of the human bones brought to England with the skull.

The total of several hundreds of animal bones proved to be of very considerable interest, and established in a short time the true nature of the bone cave. As they were sorted, bone by bone, it was seen first of all that they represented a very large variety of mammals with some birds and possibly one or two larger reptiles. The mass of the bones belonged to ungulates, but there were also a few carnivora. Nearly all the bones, however, showed characteristic old breaks and cleavings. The skulls and even the horns were all broken into large pieces; the hip bones and shoulder blades were broken much and irregularly; while the long bones, even those of the larger birds, were generally broken at or near their middle, in addition to which a number of the extremities of the tibia and femur were cleft in two longitudinally so as to expose the whole cavity. There were no marks of teeth on the bones, not even of the teeth of rodents, and little of damage outside the main breaks. But these breaks were produced, it was seen again and again, not accidentally or by the teeth of animals, but by man; and not by sharp cutting and cleaving tools, but evidently by stone implements.

The lesson was clear. These were the bones of animals utilized for food by some native group of men, and the bones had been purposely and systematically broken by these men to get at the marrow. The horns were broken for the same purpose. Moreover a number of the bones showed more or less the effects of fire; and in several instances there were found two or three pieces of what was originally the same bone, or again two bones proceeding plainly from the same animal. The lower halves of the two humeri of a young hyena, broken in the same manner as the other bones, were among the collection.

All this indicates that the cave had been used for a long time by some group of native population as a habitation, or at least as a place where parts of animals were brought, cooked or roasted, and eaten. Among the bones the writer found a few flakes, and a piece of quartz that may have been partly shaped by man. It had a good cutting edge which would have been serviceable. The main bone cave may therefore confidently be characterized as a cave of prolonged occasional or permanent human habitation in some part of the past, perhaps not very far distant. How far will depend on the identification of the animal forms whose bones were left in the cave. Bones from the outer part of the cave identified previously were, we have seen, practically all of forms that are still living.

The newly found human bones proceed from two skeletons; the arm bone is that of a strong adult male; the parietal, rather thin, is probably that of an adolescent. They apparently have no connection with the " Rhodesian skull." But lying as they did among the broken animal bones, and in the case of the humerus being fractured crosswise by a blow as was the rule with the animal bones, a suspicion is aroused that they may have belonged to human beings who suffered the same fate as the animals. The new evidence throws no light either upon the racial character or the antiquity of the remarkable cranium.

The two new human fragments, the mammalian teeth and a selection of the animal bones were deposited by the writer, together with a quartz ball and the above mentioned stone, in the British Museum (Natural History), South Kensington, so that they might be with the Rhodesian skull and the other specimens collected previously. On this occasion the writer was able once more to examine the Rhodesian skull and also the other human bones that were received with the skull. They are: a portion of a separate upper jaw with two teeth; a tibia; two parts of a male adult femur; one shaft of a female adult (?) femur; a large part of a right female (large notch) *os coxae;* a large part of a male ilium (small notch); and one sacrum. Of these the upper jaw, mineralized, is somewhat different in color from the skull. While it is considerably heavier than normal, morphologically it is in all ways like the jaw of a modern negro, with modern teeth, and bears no resemblance to the corresponding part of the Rhodesian skull. The tibia is much more reddish-brown than the skull; the female femur is light ochre-yellow; the male femur pale to blackish-brown with thick walls. One of the pelvic parts is near in color to the skull, the other is distinct.[1] The male femur is in two parts, with the middle portion missing; the breaks are old and both fragments show superficial slivering from knocks.

The writer feels strongly that these bones should not be associated with the Rhodesian skull. They are all in every respect of modern form and size. They may belong to the contents of other parts of the cave, or at least to entirely different human beings. All, with the exception of the tibia, show old breaks, which may be an indication of cannibalism. At least it may be said that it would be unsafe, before further evidence may throw more light upon the matter, to build on the basis of these bones any conclusions as to the skeletal characters of the original owner of the Rhodesian skull.

As to studies of the Rhodesian remains, Dr. A. Smith Woodward gave two preliminary notices of the find,[2] and notes on the skull were published later by Eugene Dubois,[3] Sera,[4] Martin,[5] Hambruch,[1] and Boule,[2] while Elliot Smith,[3] commented mainly on the brain. The most complete account of the specimen so far published, however, is that of Sir Arthur Keith in the recent second edition of his "Antiquity of Man";[4] but unfortunately it includes some of the misinformation about the circumstances of the discovery (p. 382, upper paragraph) with its consequences.

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[1] In this connection the writer is glad to print the following letter referring to something that may, but apparently does not wholly, account for the differences in color and consistency of the bones (particularly one of the femurs) in question:

Department of Geology, British Museum (Natural History),
2 March, 1926.

DEAR DR. HRDLIČKA:

I have just had occasion to read your letter of the 12th November, 1925, addressed to Dr. Bather. In it you state that the skeletal remains from Broken Hill differ from the skull and from each other in colour and state of mineralisation. May I point out that this is not really the case, and that the reason for varying colour is a difference in method of treatment by the preparators? The skull was painted over with a thin solution of shellac soon after it was received here; this darkened the colour a little. The remainder of the bones, with the exception of the two innominates, were soaked in "wulfite" about 12 months ago. This caused the dark colour and also increased the weight very considerably. The innominates have not been treated in any way; they represent the original condition of all the others.

Yours truly,
(Signed) ARTHUR T. HOPWOOD.

[2] Woodward, Arthur Smith, A New Cave Man from Rhodesia, South Africa. Nature, Vol. 108, pp. 371-372, 1921; The Problem of the Rhodesian Fossil Man. Sci. Progress, Vol. 16, pp. 574-579, 1922.

[3] Dubois, Eugene, On the Cranial Form of *Homo neanderthalensis* and of *Pithecanthropus erectus* Determined by Mechanical Factors. Konink. Akad. Wetensch. Amsterdam, Vol. 24, pp. 313-332, 1922.

[4] Sera, G. L., Rivista di Biologia, Vol. 4, p. 2, 1922.

[5] Martin, R., Der neue Schädelfund von Rhodesia. Mannus, Z. f. Vorgeschr., 1922.

The writer did not wish to anticipate the eventual description of the specimen by his English colleagues. But he has been kindly allowed to take a few measurements on the original, and these measurements, with those previously published by others, are given in the table on page 130. The specimen is difficult to measure, which, with instrumental imperfections, doubtless accounts for some of the differences in individual determinations.

CRITICAL REMARKS

The Rhodesian find of 1921 is more complex than has been generally appreciated. Due to the absence on the spot of any scientific man exact details of the find have not been ascertained. Of what was learned but little was recorded, and of the rest much has since become confused. The precise circumstances of the discovery are therefore, and must remain, deficient.

The main part of the bone cavern was evidently for a long time a habitat or feasting place of late Africans, bushmen or negro. The larger bones were none of them brought in by animals, but were the remains of the repasts of the black man. A very large majority were broken for the marrow. Similarly broken human bones suggest cannibalism. There were apparently no human burials in the cave. How the strange Rhodesian skull got in is inexplainable.

The skull was found alone in the lowest and most remote part of the cave, some distance beneath considerable accumulations of soft pure lead ore. There was neither lower jaw nor skeleton. One human bone, the tibia, and parts of a lion's skull, it is well established, lay from a few to about ten feet from and at a lower level than the skull.

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[1] Hambruch, P., Der Schädel von Broken Hill Mine in Nord Rhodesia. Arch. f. Anthrop., Vol. 19, pp. 52-56, 1923.

[2] Boule, M., Fossil Man, Edinburgh, pp. 481-486, 1923.

[3] Smith, G. Elliot, Brit. Med. Journ., 1922, I, 197; Atlantic Monthly, Apr., 1922.

[4] London, Vol. 2, pp. 377-393, 5 illustrations, 1925.

See also "The Sufferings of the Rhodesian Man," Lancet, 1922, pp. 1206-7; and Siffre—"L'ineptitude dentaire des hommes préhistoriques," La Semaine dentaire, Vol. 7, Nos. 12 and 13, pp. 300-308, 322-328, 1925.

As to the other human bones deposited at the British Museum with the skull, and those now added, all that may be said is that they proceed from several skeletons of modern size and form; that some of them, at least, probably came from other parts of the cave; and that there is no proof, and but a remote possibility, of any of them belonging to the skull.

The skull itself is positively not the skull of any now known African types of man or their normal variants. Neither is it any known pathological monstrosity, such as gigantism or leontiasis. It is a most remarkable specimen of which the age, provenience, history, and nature are still anthropological puzzles.

Morphologically the skull is frequently associated now with the Neanderthal type of Europe. This may be fundamentally correct, but only to that extent. In its detailed characteristics the specimen in some respects is inferior, in others superior to anything known as yet of the Neanderthal man.

Meanwhile mining operations at Broken Hill are proceeding. They will gradually do away with what may still remain of the former bone crevice; and they will soon, if they have not already, involve the second kopje with its crevices. All this work should be intently watched, for any day it may uncover new evidence of much importance.

THE BRITISH MUSEUM REPORT ON THE RHODESIAN REMAINS

While the preceding was in preparation the long expected British Museum report on the Rhodesian remains appeared. It is a compound report, by 8 authors, with an introduction by Dr. Bather.[1] The skeletal remains are not described by Sir Arthur Smith Woodward, but by the zoologist of the Museum, Mr. Pycraft;[2] while the brain, as seen from an endocranial cast, is ably studied by Professor Elliot Smith.

Dr. Bather's succinct preface and introduction, in view of the history of the find as published in 1925-26 and recorded in the preceding pages, leaves the student unsatisfied.

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[1] Rhodesian Man and Associated Remains. British Museum, London, 1928. Preface and Introduction by F. A. Bather, pp. iii-iv, ix-xiii. Description of the Skull and Other Human Remains from Broken Hill, by W. P. Pycraft, pp. 1-51, 3 pls., 11 figs. Endocranial Cast Obtained from the Rhodesian Skull, by G. Elliot Smith, pp. 52-58, 7 figs. The Pathology of the Left Temporal Bone of the Rhodesian Skull, by M. Yearsley, pp. 59-63, 1 fig. The Teeth of Rhodesian Man, by J. T. Carter, pp. 64-65, 1 fig. The Associated Stone Implements, by R. A. Smith, pp. 66-69, 2 figs.; and, The Fauna, by A. T. Hopwood, Dorothea M. A. Bate, and W. E. Swinton, pp. 69-75, 1 fig.

[2] The essential measurements in Mr. Pycraft's account should tally with those of the writer, for they were made jointly (Nov., 1927).

THE SKULL

Mr. Pycraft has done a very conscientious piece of work. If, as appears from the reviews of his work, his conclusions are not meeting with favor, it is mainly because he has chosen to associate organically with the Rhodesian skull remains of which no man can say with full confidence that they belong to it; because he has seen more in the morphology of these additional remains than others can see; and because he makes of the Rhodesian man a new genus ("Cyphanthropus"). These are all grievous sins which may or may not be outweighed by the painstaking work on the skull. However this may be, it will be but proper to quote Mr. Pycraft's main conclusions on the cranium. They are:

> Highly specialised in some particulars, this skull must nevertheless be regarded as of a relatively low type, having a definite resemblance to the skulls of Neanderthal Man, with which race it has affinities.
>
> Its specialised characters are perhaps most marked in the enormous supraorbital torus, whose likeness to that of the Gorilla seems to have been somewhat over-emphasised. The distance between the styloid process and the mastoid, and the greatly developed nuchal plate, are apparently correlated with the very large, broad, and flat face. Similarly, the height of the maxilla, a markedly simian character, is closely correlated with the sub-nasal length. The face was mesognathous, and not prognathous as would at first appear. Others have already commented on the great size of the palate, but it seems to have escaped attention that this palate was once even larger. The reduction in size began with the decay of the teeth. As the alveoli closed up, the palate shortened.
>
> When the contours of the Rhodesian and Gibraltar skulls are superposed there is seen to be an undoubted likeness between the two. Similar resemblances between this skull and that from La Chapelle further justify the suggested affinities with Neanderthal Man. They seem, however, to be derived from a common stock rather than directly related. The superposed contours of the Rhodesian skull and of a skull from St. Edmond's Priory, selected at random as a type of the modern skull, brings out two important features. It shows that the frontal fossa is much longer in modern Man, and that the cranial cavity has greatly increased in height.
>
> When this skull is orientated on the Frankfort plane, the low forehead and the rapidly sloping parietal roof at once attract attention. In longitudinal section it will be noticed that the floor of the posterior cranial fossa was essentially as in modern skulls. The *clivus* is steep, though not more so than in many modern skulls, but it is longer, thus raising the *dorsum sellae* and the pituitary fossa some 8 mm. higher than they are in the St. Edmond's Priory skull.
>
> There are other features which seem to indicate that Rhodesian Man was nearer to the Chimpanzee and Gorilla than was Neanderthal Man. Thus, if a longitudinal section of the face of the Gorilla or Chimpanzee be examined, it will be found that a line drawn at right angles to the alveolar border, and immediately behind the last molar, will pass upwards just behind the torus, and in front of the cerebral cavity. This is true also of the Rhodesian skull. But in Neanderthal Man this line cuts through the fore-part of the anterior fossa, and in

> modern Man it cuts through the fossa about mid-way between the glabella and the bregma; sometimes almost at the bregma.
>
> The Rhodesian skull, on the other hand, recalls Neanderthal Man, and especially the Gibraltar race, in the width and form of the nuchal plate, the supra-occipital region of the skull; but it is much larger.
>
> Some further, and very significant, features are brought out when the Rhodesian skull is compared with that of the Chimpanzee and Gorilla, orientated on the meato-nasion line. . . . .
>
> The meato-lambda angle (46°) of the Rhodesian skull is noteworthy. In modern human skulls it varies between 50° and 60°. A further peculiarity is the fact that the meato-lambda line, produced downwards and forwards, passes through the maxilla to the prosthion. In all other human skulls it passes beneath the jaw. . . . .
>
> Finally, the thickness of the skull-wall in Rhodesian Man was not greater than in many existing races. Considering the many simian features of the skull this is noteworthy. In the anthropoids, owing to the compression of the intermediate layer of cancellated tissue, the cranial wall is markedly thinner. From the tusk-like canines of the great anthropoids one would have supposed that a thick skull-wall would have been necessary.

An additional interesting paragraph is found in Mr. Pycraft's account under "Affinities" (p. 48); it deserves to be quoted in full:

> There are differences of opinion on the affinities of Rhodesian man. Sir Arthur Smith Woodward regards him "as a primitive species of true man, in which a slightly incomplete development of the brain is accompanied by an enlargement instead of a reduction and refinement of the face." That is to say, he does not regard him as Mousterian. Prof. Elliot Smith on the other hand remarks that, "in the bones found in the Broken Hill mine, we have the remains of a type of mankind definitely more primitive than all the known members of the Human Family, with the exception only of *Pithecanthropus* and *Eoanthropus*." Sir Arthur Keith regards him as near the ancestor of Neanderthal and modern Man; "he has assumed too much of the modern type to serve this purpose [*i. e.*, to be regarded as the ancestor of both]. His just place seems to be in the modern stem soon after this stem had broken away from the Neanderthal line." The striking likeness between the Rhodesian and Gibraltar skulls, and the undoubted likeness to the La Chapelle skull, is convincing evidence of a common relationship, if not of a common descent. This is expressed, with slight differences, by all three of the authorities quoted. Rhodesian man, then, is to be regarded as an independent development of the nascent Neanderthal stock, an opinion which would explain both the resemblances to and the differences from the Neanderthal race.

Mr. Pycraft's excuse for associating the tibia, pelvis, etc., with the skull, is, finally, as follows (p. 49):

> It may be urged that there can be no certainty that the remains of the axial and appendicular skeleton and the skull are all parts of the one individual. This is doubtless true, but, when the outstanding features of these several parts are critically studied, it is found that they display a reciprocal inter-relationship so intimate that any attempt to dissociate the skull from the remaining parts of the skeleton must do violence to all ordinary rules of evidence and inference.

THE BRAIN

Professor Elliot Smith shows the volume of the brain of the Rhodesian skull to have been but 1280 cc., which is markedly smaller than in any of the Neanderthalers with the probable exception of the Gibraltar female.

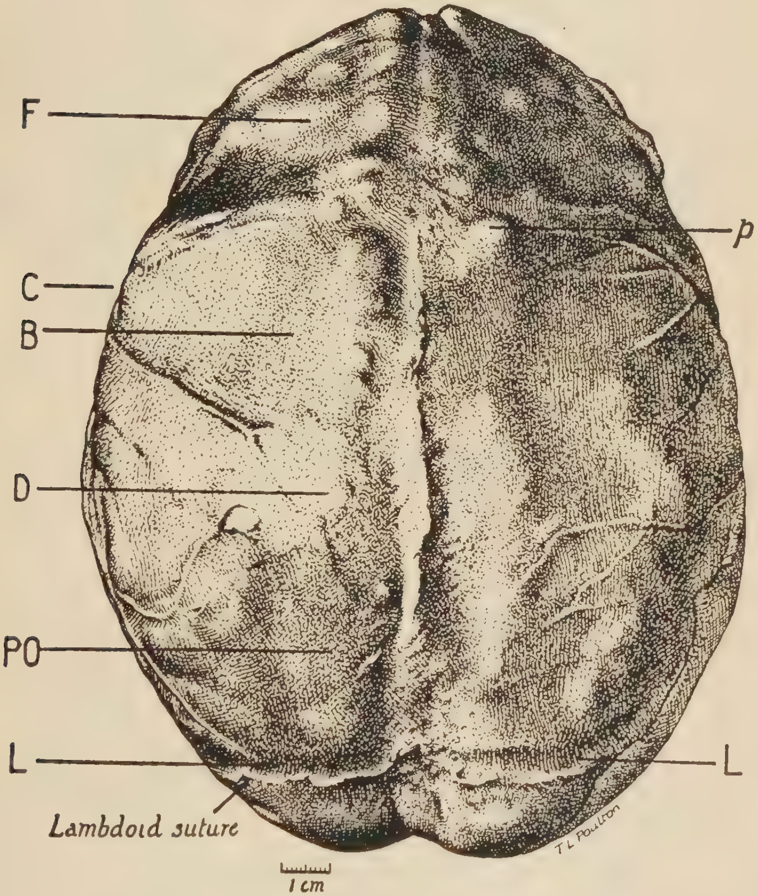

FIG. 10.—Rhodesian man: endocranial cast, top view. (After G. Elliot Smith, 1928.)

The very successful cast shows the brain to have been in general very definitely human, related to that of the Neanderthalers, and superior to both that of the Pithecanthropus and Eoanthropus [? skull too defective].

The general contour of the brain and the peculiarities of its form and proportions suggest the kinship of Rhodesian man with the Neanderthal species. The great deficiencies in development of the prefrontal, upper parietal, and inferior

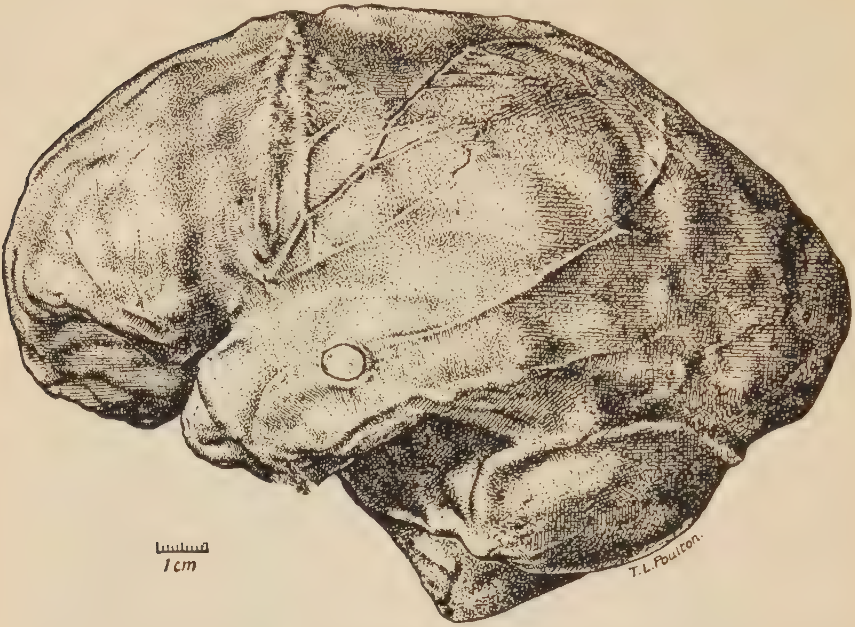
1 cm
T.L.Poulton.

FIG. 11.—Rhodesian man: endocranial cast, side view. (After G. Elliot Smith, 1928.)

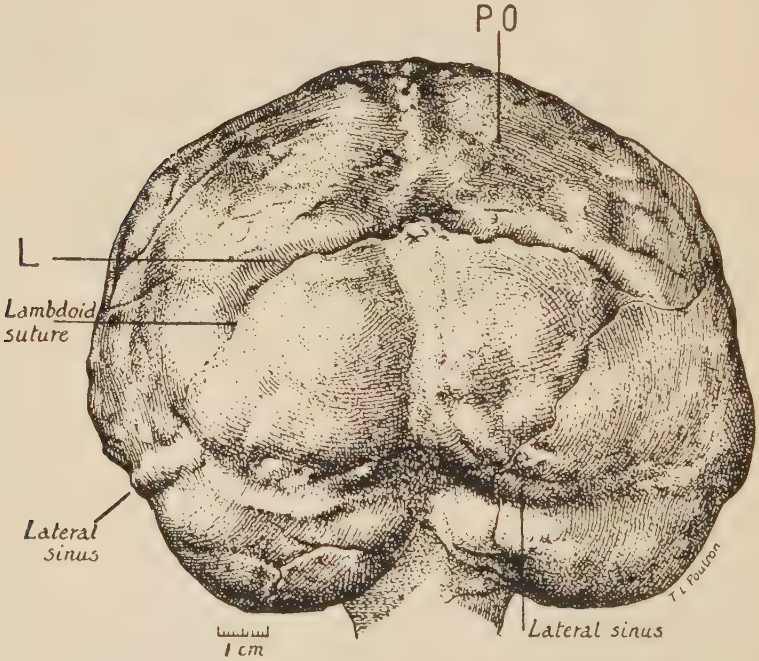
PO
L
Lambdoid suture
Lateral sinus
Lateral sinus
1 cm
T L Poulton

FIG. 12.—Rhodesian man: endocranial cast, occipital portion. (After G. Elliot Smith, 1928.)

> temporal areas, however, clearly differentiate it from the Neanderthal type and reveal a condition of affairs definitely more primitive. The defective development of the brain cannot be the result of a secondary degradation, because its features conform so strictly to the primitive type. . . . . It can be said with confidence that the Rhodesian cast reveals features definitely more primitive than those of the Neanderthal species.

The maximum length of the cerebral hemisphere is 17.0 cm., and the maximum breadth 13.5 cm. (at the posterior extremity of the temporal region) ; Cerebral Breadth-Length Index *79.4*.

The details given are rather meagre and relate principally to the apparent localized deficiencies. "It is this defective development of certain areas that differentiates the Rhodesian brain from that of the Neanderthal series, and, with various cranial characters, justifies the creation of a new species [genus ?] of a more primitive rank."

PATHOLOGICAL FEATURES OF THE SKULL

In the anterior part of the left mastoid are the apparent marks of mastoiditis, and a small hole appears in the left temporal squama. Dr. Yearsley summarizes the results of his study as follows:

> The conclusions to be drawn from a study of this remarkable specimen of prehistoric pathology must necessarily be hypothetical. The most plausible hypothesis that I can form is that the subject was a sufferer for a considerable period from chronic sepsis, as evidenced by the state of the teeth and alveolar border and the fact that the tibia shows signs of periarthritis or arthritis. The chronic septic condition of the mouth led to suppurative middle ear disease, complicated with mastoid abscess. That this abscess broke through the cortex at the base of the mastoid and tracked upwards into the temporal fossa along the line of least resistance, and that it broke later through the tip of the process, tracked down the neck into the thorax and thus caused death.
>
> It is strongly presumptive that the perforation B is not an instance of primitive "trepanning," but was due to a wound inflicted by some sharp instrument during life and was not the cause of death.

THE TEETH

Concerning the teeth, Dr. Carter gives but one conclusion, which is that: "The dentition is essentially human."

He gives such few measurements of the teeth as their diseased or worn condition permits.

THE STONE IMPLEMENTS

Dr. Smith's note on these specimens is brief, the material offering but little variety. The essentials of his report are so succinct that they may be given in full. He states:

> The largest chert flake is roughly oval and three inches long; another is shaped rather like a Le Moustier "point," and a third (honey-coloured) looks like a

slice from the foot of a plane, to produce a new cutting-edge. A stone ball like figure 228 has slight facets which are bruised like the rest; and there are four imperfect spherical hammerstones of quartz, the largest having a diameter of 3.4 inches. The largest piece of milky quartz (3.2 inches) is probably due to natural fracture; but there are six broad flakes, subtriangular, clearly of human origin, the largest being 2.3 inches; and five that may be classed as blades, with the side-edges nearly parallel. Two other specimens appear to be pointed ends of flake implements, the larger being an equilateral triangle, 0.6 inch thick at the center. A flake of clear quartz, 1.8 inches long, has a calcareous deposit, and a fragment of fossil bone resembles the butt of a thin-butted celt, heavily striated and rubbed smooth in places. A pointed granitic stone of triangular section, 8 inches long, seems to be battered at the pointed end, but was probably not shaped by man, though the butt has a smooth and rounded edge. . . . .

Mr. Franklin White, who collected some of the specimens under consideration, has himself contributed some notes to the Proceedings of the Rhodesia Scientific Association, Vol. IX (published 1910), on further discoveries in the cave; and enumerates bone implements and tusks as well as quartz artifacts from 1 inch to 4 inches in length. The material is described as semi-opaque white, not at all suitable for implements, and not produced in the locality, but brought from a distance with the large rounded quartzite pebbles. The most common type of implement, he says, is a leaf-shaped lance-head, with the butts badly finished off. Ridged flakes were abundant, and one was found of transparent quartz. Several small flakes could have been used as arrow-heads, but there was only one round-scraper in his series. No bone ornaments such as discs or beads were noticed: and the broken bones and implements were found throughout 18 feet of filling, with one piece of semi-vitreous clinker that proved the use of fire by the primitive cave-dwellers.

Upon the writer, who collected and brought to London some of these specimens, the material makes no impression of antiquity. It is to be compared with recent South African stone industries, rather than with any of the paleolithic industries in Europe. There is no possibility of a definite association of the specimens with the skull.

THE FAUNA

Mr. Hopwood has identified the mammals of the Broken Hill cave. He tells us as follows:

The study of the mammalian bones found at Broken Hill was undertaken in the hope that they might afford some evidence as to the age of the human remains found in the cave. It seemed reasonable to suppose that, if the contents of the cavern were of any degree of antiquity, there might be found portions of animals which are extinct, or, at any rate, of species which are not at present represented in the fauna of Rhodesia. This hope has been realised only in part. The cave fauna is composed of living forms with the exception of *Rhinoceros whitei* Chubb and a new species of Serval cat.

To which he adds:

In considering the significance of the Cave fauna of Broken Hill there are two things to be kept in mind. First, that it is impossible to determine the relative levels occupied in the deposit by relying on the degree to which the bones are mineralized. For example, the human remains, from the very lowest part of the cave, are only slightly impregnated with ores of lead and zinc, whereas bones of Hyaena and Wart Hog, from an unknown horizon, are so charged with mineral matter that they give a clear note on being sharply struck. Secondly, it is also well to remember that the African continental plateau is of extraordinary stability, and that it has been a land area from very early times. Furthermore, the climate has always been tropical or sub-tropical, at least to the south of Egypt. Hence, apart from possible changes in the rainfall, conditions of life have been comparatively fixed and the fauna is not likely to have altered in character so rapidly as in other regions, Europe and North America for instance, where great changes in the climate and geography have taken place in comparatively recent times. For these reasons it is practically impossible at present to estimate the age of African cave deposits by means of the fossil mammals. The fact that two extinct forms are known proves nothing. It is becoming ever more apparent that the mammal-bearing horizons of Central Africa are not comparable in age with those of Europe, and that in dealing with them it is useless to apply European standards. On the evidence of the associated mammalian fauna there is no reason to suppose that the human remains are of anything but recent date.

The bird remains, identified by Miss Bate, are few in number; "it is probable that all the remains represent species still found in the locality."

"The reptilian remains associated with the Rhodesian skull are few in number and belong to species still existing in the locality." (W. E. Swinton).

DESCRIPTION OF THE SKULL AND TIBIA

Since the British Museum has published its report on the Rhodesian man, no objection can be had to an additional description. Thanks to Dr. Smith Woodward and later to Dr. Bather, the writer has been able repeatedly to examine and measure the originals (1922, 1923, 1927). The last measurements (Nov., 1927), to insure accuracy and agreement, were made by well-tested instruments in the presence of Messrs. Pycraft, Bather, and Hopwood of the British Museum, and have been utilized by Mr. Pycraft.

THE SKULL

The skull is monstrous; its frontal and most of the facial parts exceed in primitiveness every other known specimen of early man. The skullcap, on the other hand, from behind the frontal ridges is of a decidedly higher grade equalling in many respects and in some even exceeding those of the more typical Neanderthal crania.

The subject was plainly a very powerful male, probably over 40 years of age. The skull is in no way pathological, though showing some diseased conditions; and it cannot be diagnosed as a reversion. It represents a distinct crude variety of man, which strangely combines many ancient, even pre-Neanderthal conditions with others that are relatively modern. It could represent, conceivably, a very brutish individual development of the upper Neanderthal or the post-Neanderthal period.

The most striking features of the skull are its huge supraorbital ridges. They are not far from twice as stout as in the Neanderthalers. Moreover, they are stouter in their middle third, especially in the region corresponding to that of the supraorbital foramen. They measure near glabella, 21 mm.; in the region of the supraorbital foramen, R. 23, L. 24 mm.; and above the outer third of the orbit, R. 21, L. 20 mm.; maximum transverse diameter, 14 cm. The external biorbital diameter, between the outermost parts of the fronto-malar sutures, is only 13.4 cm., showing the amount by which the tori bulge over these articulations. No such huge welts have ever been seen in any other human specimen, nor even, if their thickness alone is considered, in the anthropoid apes. They constitute a huge exaggeration of this ancient primate masculine character.

Yet these ridges are already human rather than anthropoid in character. They do not form such a transverse promontory above the orbits with but a moderate median depression, as they do in the chimpanzee or the gorilla, but show a very marked dip downward at the glabella, approaching thus somewhat nearer to the condition seen in adult male orangs. Moreover while the surface of this supraorbital promontory faces forward or nearly so in the Rhodesian skull passing from the interorbital process outward, it becomes more and more everted until in its distal portion it looks considerably upward. In this respect it differs from the ridges of both the apes and the Neanderthalers, where such eversion is not present.

The glabella is carried considerably forward and is convex above; and posterior to the glabella is a broad depression from side to side, having a distant resemblance to this region in the female gorilla or chimpanzee; but there is no antero-posterior depression, the mid-line of the very low frontal continuing without, or with but a trace of, a sagging down to the glabella. Due to the arching of the ridges there is, however, a shallow antero-posterior depression above the outer two-thirds of the ridges; if the forehead was higher this depression would be doubtless even more marked, as it is in most of the Neanderthal skulls.

The slope of the forehead is as great as it is in some of the apes. It is diminished somewhat by a fairly marked metopic ridge which, stouter at the lower portion of the frontal squama, gradually broadens until at the bregma it forms a low elevation 35 mm. in diameter. It raises the bregma region to quite a marked elevation, which extends, dwindling gradually, to over 20 mm. beyond the coronal suture. This formation recalls strongly the similar feature on the skull of the Pithecanthropus.

The frontal bone of the Rhodesian man is also relatively very narrow, and that even posteriorly (diam. frontal min., 9.9; diam. frontal max., 12.3 cm.; index, *80.5*). Antero-posteriorly the frontal bone was relatively small, though appearing larger through the supraorbital protrusion. In its great slope, in its marked metopic ridge, narrowness, and also in its anterior flare and relative smallness as a whole the Rhodesian frontal approaches closely the frontal of the Pithecanthropus; though the ridges in the Rhodesian skull are much the heavier.

Viewed from the top the skull presents a long ovoid with a narrower end anteriorly, much as in Spy No. I and especially in the La Quina adult. The parietal eminences, however, are diffuse and located more about the center of the bone, hence less posteriorly and inferiorly than in the typical Neanderthalers. From side to side the parietal region is fairly oval (approaching circular), with but a trace of an elevation along the sagittal suture. Antero-posteriorly the outline of the skull shows the very sloping forehead, appearing somewhat higher than it is through the metopic ridge, followed by the elevation of the bregma due to the same metopic ridge. A slight postbregmatic depression is followed by an elevation at about the middle of the sagittal region, then another mild depression to the lambda, a slight bulge, and a medium convexity of the upper part of the occipital squama; below which is a pronounced transverse occipital torus, and this is followed by a practically simian flat planum occipitale. The skullcap as a whole is quite large and impresses one as massive.

The sutures of the skull, for the most part are, curiously, well knitted, especially the sagittal and coronal, coming nearer in this respect to modern man than those of the various Neanderthal skulls. The serration of the lambdoid is submedium, as compared to modern human standards.

Laterally the frontal and the parietals show uncommonly strong, though not excessively high, impressions of the temporal muscles. The nearest approach of the upper temporal line to the sagittal suture is approximately 4.8 on the right, and 4.1 cm. on the left side. Where the ridges pass the coronal suture, the bones of the skull show a fairly marked bulge, from which the temporal lines are deflected considerably upward. The temporal region is about as full as in modern skulls of similar cranial index. The temporal bones are relatively well developed. The mastoid is much larger than in the Neanderthal male skulls; it is as long and large as in modern strong male crania, but its inferior extremity, instead of being more or less pointed, is bulky and dull. Anteriorly, just behind the auditory meatus, it shows a rather large lesion (mastoiditis ?). The base of the zygoma is broad (3.2 cm.); but the zygoma itself is not excessively heavy. The external auditory meatus is in size, shape, and axis like that of modern man.

The occipital region resembles in the main that of the Neanderthalers, though it is not so relatively broad superiorly as in the latter and is somewhat fuller beneath the lambdoid suture, approaching thus somewhat more that of modern man. But the transverse torus is much more developed than that in any other early skull; passing completely across the occipital, there are traces of its prolongation on each side along the lambdoid suture to the region of the mastoid. Portions of such a torus as highly developed are found in primitive modern skulls (there are three such in the collections in the U. S. National Museum); but a complete ridge of this nature cannot be matched either in recent or in early crania.

Below the ridge there is a modern bilateral concavity from above downward, though slightly convex from side to side; and this passes on to the very moderately convex (on each side) broad plane below. These conditions approach markedly those in adult gorillas, differing much from those of recent man and also from those in the chimpanzee and orang. The conditions resemble but exceed those in the Neanderthal skulls in which these parts are preserved.

The bones of the skull, as seen on the right side, a part of which is missing, are seen to be strong, yet not excessively thick. The thickness of the right parietal squama ranges from 6 to 10 mm. This is somewhat less than in the thickest Neanderthals, and is equalled in some massive, non-pathological primitive skulls of today.

The face.—The orbits are large, deep and of irregular angular outline; yet they are more human than anthropoid. The upper borders, in particular, are stout and uneven. The interorbital septum is very stout (min. diam. 35 mm.).

Dimensions of the orbits:	R. cm.	L. cm.
Height	4.0	3.9
Breadth[1]	4.6	4.5
Index	*86.9*	*86.7*

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[1] From slightly above dacryon; at dacryon the borders of the orbits are slightly closer together.

Through the heavy arches the planes of the orbits are concave from above downward, the upper part being more forward than in modern skulls; and the plane is also somewhat more inclined outwards and backwards than it is in recent crania. This is much as in the Neanderthalers. The nasal bones are of about medium breadth but rather long, and the nasal bridge was of but very moderate height. The line from glabella to the end of the nasals is regularly and fairly deeply concave. The malar bones, while stout, are relatively low for a male; and they show but very moderate prominence forward. As in the Neanderthalers they have broad and stout frontal processes, the outer surface of which points appreciably more outward (or less forward) than in most modern crania. This, curiously, is not an anthropoid character, for in the adult anthropoids the surface of these processes points nearly directly forward.

The zygomatic process was somewhat narrower than the frontal. This again is nearer the present human than an anthropoid condition. Another plainly human feature is the antero-posterior diameter of the malars which, relatively short in the anthropoids, especially the gorilla and orang, is here of about the same relatively greater length as in modern human skulls. The masseteric border, while much stouter than in modern skulls, shows no protrusion forward and downward anteriorly, so that there is an even line from the maxilla to the zygoma. The lower borders of the orbits in the Rhodesian skull are relatively higher, in relation to the nasal parts, than they are in modern crania. In this the skull is nearer to that of the chimpanzee than are modern human skulls (in the orang and especially the gorilla the orbits are still relatively higher). The Neanderthalers show more or less similarity in this respect to the Rhodesian man. The cause of this relatively high position of the orbits is the great development of the maxilla, with an accompanying prolongation of the nose, in these primitive skulls.

The zygomatic arches are of but moderate width for such a huge skull, and the aperture for the temporal muscle is not large, being even slightly smaller than in some modern skulls. This is completely different from anthropoid conditions, where this aperture is invariably very large. The whole zygomatic arch is short, about as in modern man, and widely different again from that of the anthropoids. The suborbital surface of the maxillae and especially the frontal portions of these bones are full, approaching closely those of the Neanderthalers. The naso-frontal portions of the maxillae are as if moderately blown out from behind. The middle portion of the maxillary surface shows a very mild depression on the right, none on the left—a merest trace of the modern suborbital (canine) fossa.

The nasal aperture is somewhat ape-like. It is broad and rather rounded in outline, as in some chimpanzees and gorillas. The nasal spine is bifid, dull, and but moderately developed, not more so than in some anthropoids; and the borders of the notches show a dull grooving and ridging rising internally to beyond the middle of the lateral borders of the aperture—a simian (especially gorilloid) condition. As a whole the aperture ranges itself with those of the Gibraltar, La Chapelle, and some other Neanderthaler skulls.

The upper alveolar process is relatively enormous. It is higher and broader than in the anthropoids, and higher and broader than in any human skull seen thus far. The height from the alveolar point (lowest point between median incisors) to the lowest point of the nasal border on each side is 37 mm., while the maximum external breadth of the dental arch (discounting all pathological swellings) is 80 mm. or slightly over. There is a marked facial and especially alveolar prognathism.

The palate, dental arch, and teeth.—The palate is very high, spacious, broad in front and close to **U**-shaped. The alveolar process is strong, yet not excessively stout; it could be matched in strong male modern skulls. The teeth were 16 in number, regularly disposed; but their condition, both morphologically and as to preservation, is most interesting. The teeth are moderately macrodont by our present scale. The rear teeth are moderately, the frontal teeth markedly, worn. The canines were evidently as in modern man—their roots are but little stouter than those of the adjacent pre-molars. The molars show a marked diminution of both M 3 as in more recent crania.

Pathologically, the teeth show a unique condition for primitive skulls, viz., extensive caries. At least nine of the teeth had advanced decay, in half of the cases nothing remaining but a small shell of the tooth. The destruction is such that there is no other explanation. In addition there were some root abscesses and probably some pyorrhea. On both sides externally in the molar region there are irregular hyperostoses which, with some on the lingual side, may be of the ordinary strengthening variety, but may in part also be pathological.

The posterior nares and the surrounding parts are entirely human, except that the nares are somewhat more oblique (lower borders more forward) than they are in man of today.

The base.—The basal parts show a number of points of interest. The basilar process is relatively short and flat, and shows anteriorly a well marked pharyngeal fossa. The petrous portions show decidedly primitive conditions. They are bulky; they extend fully forward, leaving practically no middle lacerated foramina; and they are fully on the level of the surrounding parts, as in the anthropoid apes and in the most primitive recent crania.[1] The styloid processes, generally strongly developed in the anthropoid apes, are very moderate—more so than in some modern crania, and there is a small styloid process.

The foramen ovale is rather narrow and situated in the very base of the pterygoid processes, differing somewhat from that of modern skulls. The preglenoid eminence is lower and broader than in modern skulls, approaching correspondingly the condition in the anthropoids. The glenoid fossa is broad transversely and straight; it does not slope upward and outward as in many of the Neanderthalers. Mesially and posteriorly the boundaries of the fossa are considerably like those in modern man and not as elevated as in most of the Neanderthal skulls. The foramen magnum is ovoid in shape (rather conical behind) and not much above the medium modern size. Its inclination is such that a prolongation of its antero-posterior axis would pass through not far from the middle of the nasal aperture, which is much like that in not a few modern skulls; in anthropoids, as is well known, this line passes as a rule more or less beneath the dental arch.

The condyles, very moderate for a skull of this size and strength, are relatively somewhat narrow. The inferior curved line is represented by a marked torus. The digastric groove is deep but not more so than in some modern crania.

Comment.—The study of the specimen leaves an impression of anamorphism. It is a combination of pre-Neanderthaloid, Neanderthaloid, and recent characters. It is not a Neanderthaler; it represents a different race, a different variety. The specimen does not fit with its surroundings. It does not fit at all with the fine, long, essentially modern-negro-like tibia. It does not fit with any of the other human remains saved from the cave, skeletal or cultural. It does not fit with anything, the negro in particular, found thus far in Africa.

It seems impossible to conceive the specimen as a reversion. Reversions tend as a rule to manifest themselves in individual characters or in small association. The primitive conditions of the Rhodesian skull greatly surpass all this. It seems equally impossible to regard the strain of man represented by the skull as a survival to recent time. There is nothing in anthropological knowledge that would support such an assumption. Yet the diminishing third molars, the shape and size of the other teeth, the extensive caries, and other points, speak strongly against hoary antiquity.

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[1] See Hrdlička, A., Anthropometry, p. 116, Wistar Institute, Phila., 1920; also Science, Vol. 13, p. 309, 1901.

The Rhodesian skull is a tantalizing specimen to the student, who is wholly at a loss as to just where it belongs taxonomically or chronologically. It is a comet of man's prehistory.

MEASUREMENTS OF THE RHODESIAN SKULL

(HRDLIČKA, 1927)

		cm.
Vault:		
1 Length max. (g-max.), with occipital torus		20.6
1a Length max. (g-max.), discounting torus		20.2
2 Length max. from ophryon,[1] with torus		19.2
2a Length max. from ophryon, discounting torus		18.8
Breadth max.		14.5-14.6
Cranial index (with 1a length)	*71.8*	
(with 2a length)	*77.1*	
Height:		
Basion-bregma		13.0
Mean height index $\left\{\frac{H \times 100}{\text{mean of } L\ 1a + B}\right\}$	*74.9*	
Height-breadth index	*89.7*	
Endocranial basion-bregma height		12.0
Diam.-frontal min.		9.9
Diam.-frontal max.		12.3
Frontal index $\left\{\frac{\text{D. fr. min.} \times 100}{\text{D. fr. max.}}\right\}$	*80.5*	
Thickness of right parietal		6-10 mm.
Glabella to nearest endocranial point		3.4
Face and Base:		
Nasion-alveolar point height		9.3
Diam.-bizygomatic max.		near 14.8
Facial index, upper, near	*63.0*	
Subnasal point-alveolar point height		3.7
(a) Basion-nasion diam.		11.1
(b) Basion-subnasal point		10.1
(c) Basion-prealveolar point (most anterior point on upper alveolar process)		11.8
Facial angle	63°	
Alveolar angle	54°	
Orbits:		
Height:		
Right		4.0
Left		3.9
Breadth:		
Right		4.6
Left		4.5
Index	right *86.95* left *86.7*	

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[1] Ophryon can be determined but approximately as a point just above what is plainly the forestructure and not yet the forehead.

		cm.
Nose:		
Height		5.8
Breadth		3.1
Index	*53.4*	
Upper Alveolar Arch:		
Length		7.0
Breadth max. (without excrescences)		8.0
Index $\frac{(L \times 100)}{B}$	*87.5*	
Palate, height max., just back of M 2		1.8
Dental arch, length		6.1
Dental arch, ext. breadth at the canines		5.5
Foramen Magnum:		
Length		4.1
Breadth, near		3.2
Additional Measurements on the Vault and Face:		
Nasion-opisthion		4.9
-bregma		13.8
-lambda		25.7
-inion (less torus)		28.7
-opisthion arc, less torus		36.7
-opisthion arc, over torus, close to		37.8
Supraorbital arch, max. breadth		14.0
External biorbital diam. (at fronto-malar sutures)		13.4
Bimalar diam. (malar notch to malar notch)		13.6

THE TIBIA

Of all the human bones from the Broken Hill cave, a clavicle and the tibia only have been mentioned as having been seen more or less in the vicinity of the skull and could conceivably belong to the same skeleton; it is therefore incumbent on the student to give these specimens careful attention. The collar-bone, however—if such it was—has not been saved.

The tibia was studied first by Keith, and recently by Pycraft who compared it with a Bantu tibia and found it more primitive in some respects, especially about the mesial condyle. If he had compared it with a fairly large series of male negro tibiae he would probably have found, as does the writer, that not only does it not possess a single character which is not within or close to the normal range of variation of the negro, but that, in addition, it is remarkably negro-like in its distinctive features, differing correspondingly from other recent and especially from all the known early tibiae.

The tibia is that of the left side of a rather tall male adult of evidently middle or slightly beyond middle age. The bone is long and, relatively to its length, rather slender; all the known early tibiae are short, squatty.

Principal measurements (Hrdlička):

	The Rhodesian tibia cm.	500 tibiae of miscell. American white males cm.
Length, "in position" less spine (cast)	41.3	36.5
Length max., less spine (cast)	41.6	36.8
At middle:		
Diam. antero-post., max. (on original)	3.40	3.13
Diam. lateral (with anterior border of bone midway between the two branches of the sliding calipers) (on original)	2.45	2.22
Index at middle	*72.1*	*70.9*
Shape of shaft at middle—Type 4 (moderately quadrilateral—posterior surface divided by a vertical ridge into two surfaces)		Similar type in 11.5 per cent of male white tibiae

The bone is almost perfectly straight, which is neither the case with the tibiae of early nor with a large majority of those of recent man, with two marked exceptions—tibiae of precisely this form are typical of the tall negro, and bones of same nature have recently been found, with somewhat but not fully negroid (proto-negroid?) skulls, in late prehistoric burials in British East Africa by Mr. Leakey.[1]

The Broken Hill tibia shows certain peculiarities which at first sight seem to separate it from others. These consist in a certain slenderness and more than ordinarily marked bilateral concavity, mesially and laterally, below the condyles. In addition there is a smooth surface above the tuberosity, somewhat concave from side to side, and a pronounced large faceted eminence outside of this concavity, below the anterior border of the lateral condyle. There is seen further, just below this eminence, a marked looping ridge. It passes upwards and outwards from the tuberosity, forms the lower boundary of the subcondylar eminence, then passes backward to within a few millimeters of the fibular facet, turns in a loop downward and forward, reaches the middle of the lateral surface and then descends, diminishing, down this surface to the middle of the shaft where it merges with the lateral border of the latter. The facet for the fibula is somewhat raised inferiorly. The medial condyle and its articular facet show a fairly marked inclination backward. And there are a few minor points.

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[1] The interesting originals, composing an important collection, were kindly shown to me in 1927 by Mr. Leakey at the College of Surgeons, London, where they were being studied by the discoverer.

All these features will be encountered, though probably not all in the same specimen or to quite the same degree, on negro, old Egyptian, and various recent tibiae, if there is ample material for comparison.

The mild concavity from side to side above the tuberosity is due to the pronounced development of what should be called the ilio-tibial tubercle and facet, which serve for and are developed by the attachment of the ilio-tibial fascia. The tubercle may be encountered with varying frequency, and at times strongly developed, in the tibiae of all races. Its pronounced development in the Rhodesian tibia indicates merely an exceptionally strong development of the fascia and not a phylogenetic peculiarity of the bone.

Much the same may be said of the looping ridge. All its elements are found in occasional late and recent tibiae, separately and even combined.

The inclination and other characteristics of the medial condyle and of its articular facet are comprised in the above generalization. This condyle shows moderate marginal exostoses which are evidence of arthritis deformans, and that this disease is capable of modifying the mesial facet in its inclination and other characters is well known. The posterior border of the facet has been damaged, which influences its aspect and makes it appear more inclined backwards than is actually the case. But even thus the inclination backward of the condyle and its facet can be matched and even exceeded in recent bones.

It would be useless in this place to go into detailed comparative measurements and more minute descriptions; it will suffice to repeat that there is not one feature or dimension of the Rhodesian tibia that may not be found also in the tibia of the tall African blacks and other recent bones. There is no one among the 50 negro tibiae of both sexes that were used for comparison that equals in all respects that of the Broken Hill, but there is also not one of the negro bones that is fully equalled by any of the others, each specimen having more or less of individuality.

The fibular facet, the conformation of and below the posterior border of the upper surface, the size and shape of the shaft, the popliteal ridge, nutritive foramen, the lower part of the shaft, the maleolus, and the lower articular facet, all are close to or identical with corresponding features in individual negro and other modern bones.

There is not a point here, as in the rest of the bone, that could justly be designated as exceptionally primitive and belonging distinctly to an earlier human estate. The bone, notwithstanding some individual traits, is one of late, if not recent human type, and a type that is closest to that of the African negro. The bone does not harmonize at all with the Neanderthal tibiae, and does not correspond in primitiveness to the skull. Its identification with the latter, unless proved by further discoveries, can remain but little more than a suggestion.

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APPENDIX I

ABSTRACTS FROM ORIGINAL REPORTS ON THE RHODESIAN CAVE

1907—Mennell, F. P., and E. C. Chubb. On an African Occurrence of Fossil Mammalia Associated with Stone Implements.[1]

Our investigations have been chiefly based on specimens in the Rhodesia Museum presented by the Broken Hill Company, Mr. Franklin White, Mr.

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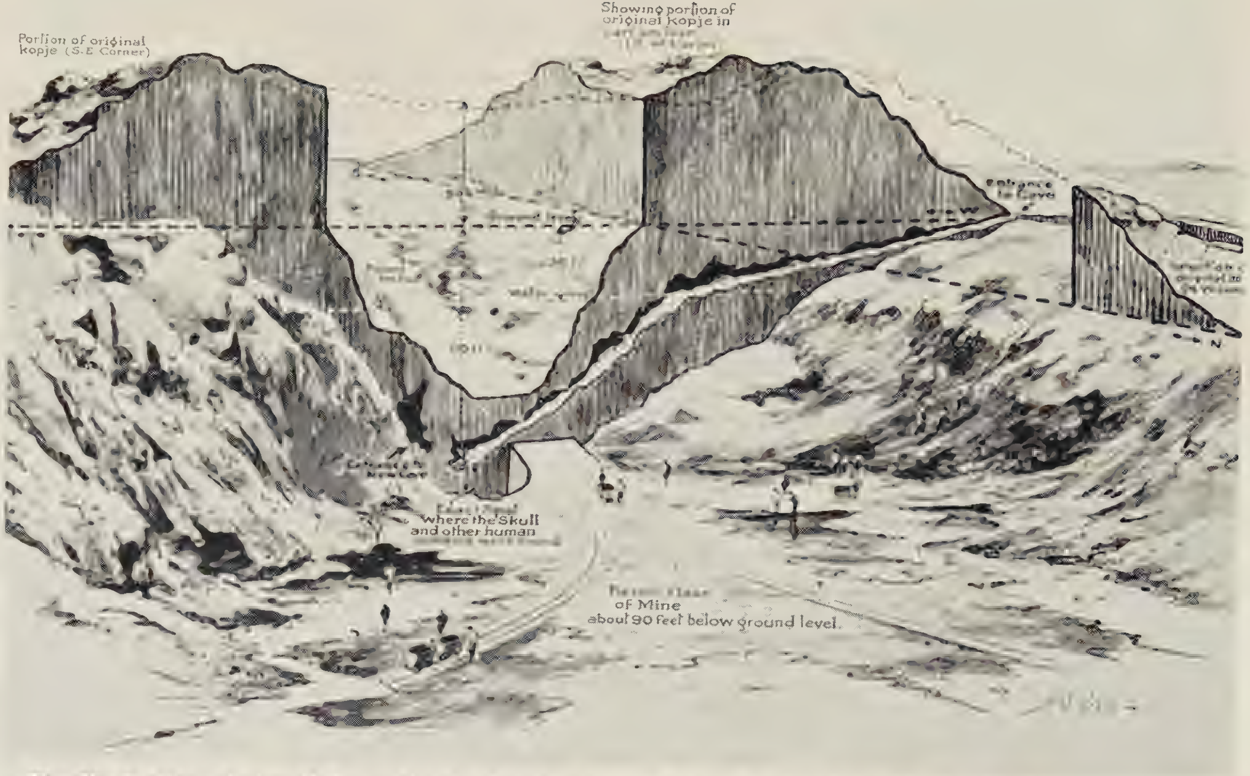
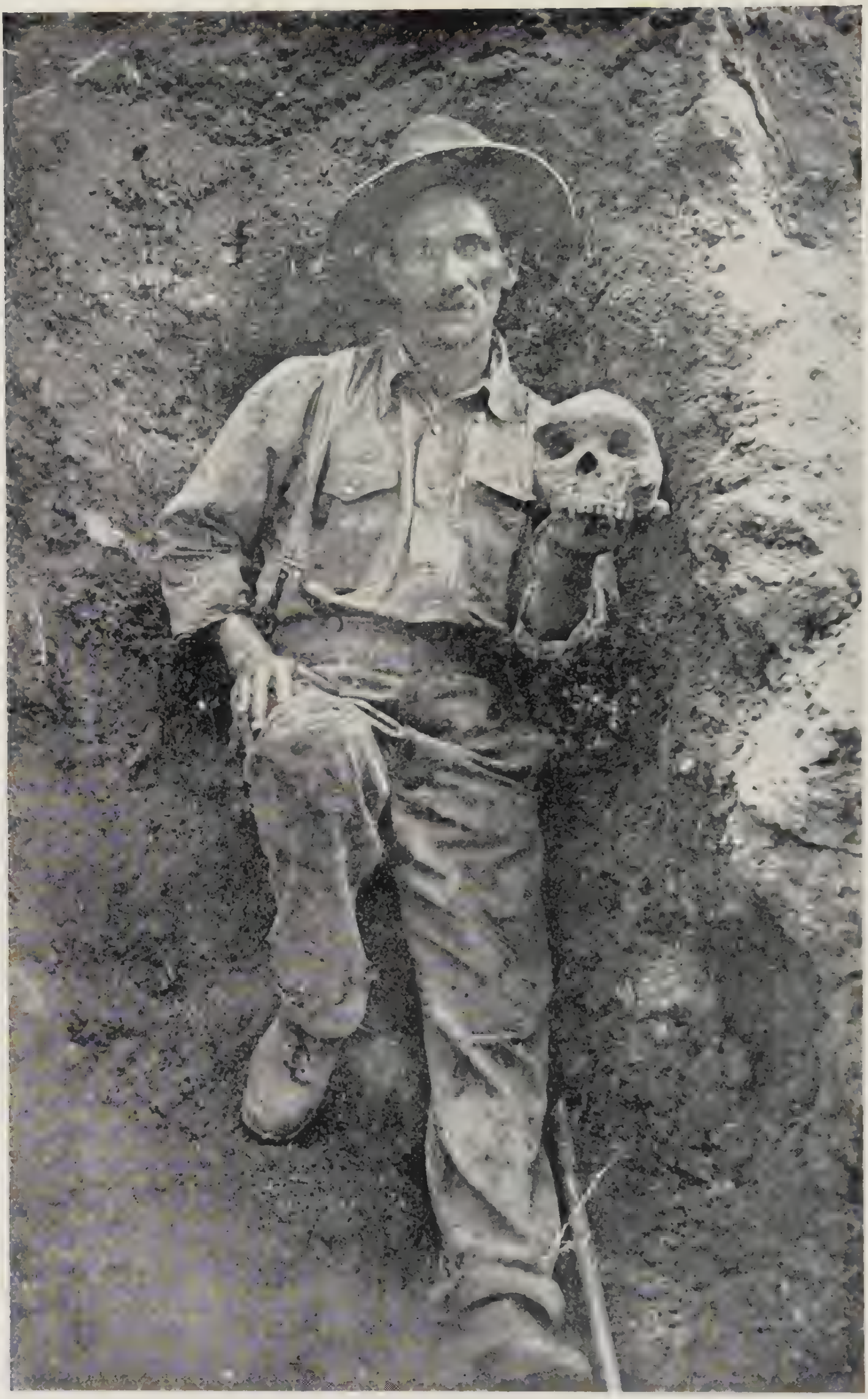
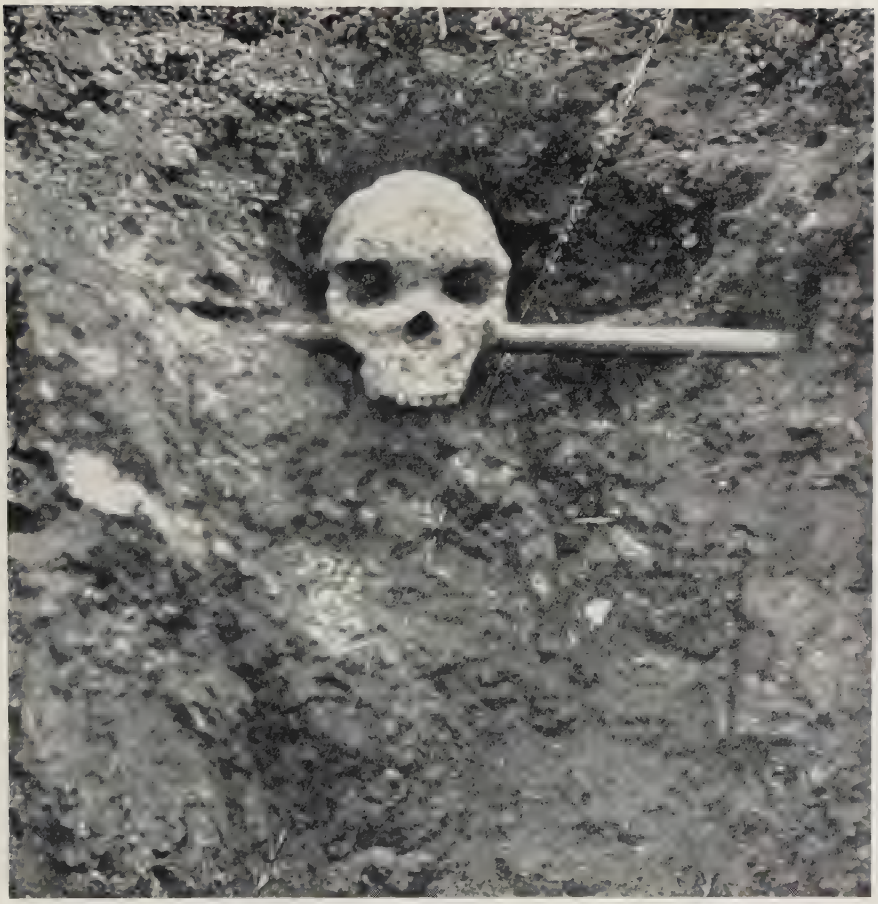
[1] Proc. Rhodesia Sci. Assoc., Vol. 6, Bulawayo, 1907.


Portion of original
kopje (S.E Corner)
Showing portion of
original kopje in
Entrance to Cave
where the Skull
and other human
of Mine
about 90 feet below ground level.

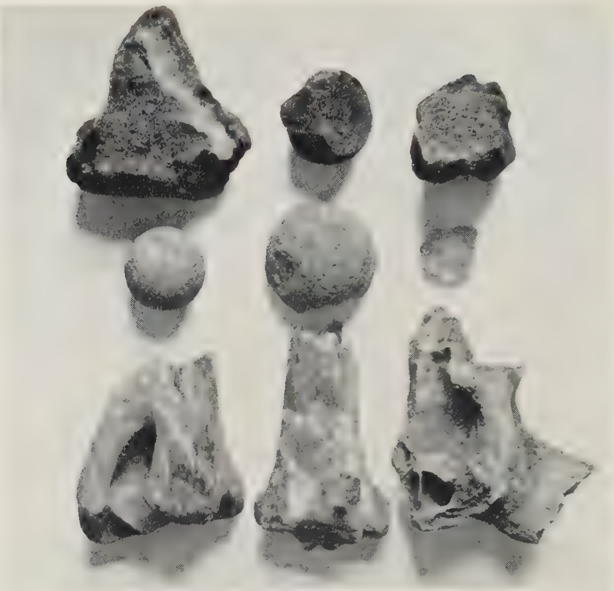
The Rhodesian or Broken Hill cave shortly after the discovery of the Skull. (After The London Illustrated News.)



Mr. Zwigelaar, the discoverer of the Rhodesian skull, shortly after the find was made. (Photograph given Hrdlička by Mr. Zwigelaar, 1925.)



The Rhodesian skull, shortly after its discovery, placed by Zwigelaar "exactly as and where it lay," to be photographed. (Photograph given to Hrdlička by the authorities of the Broken Hill Mine, 1925.)



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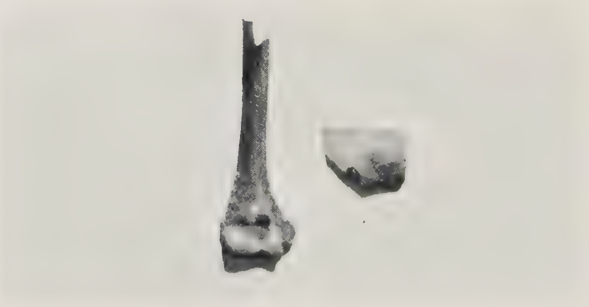

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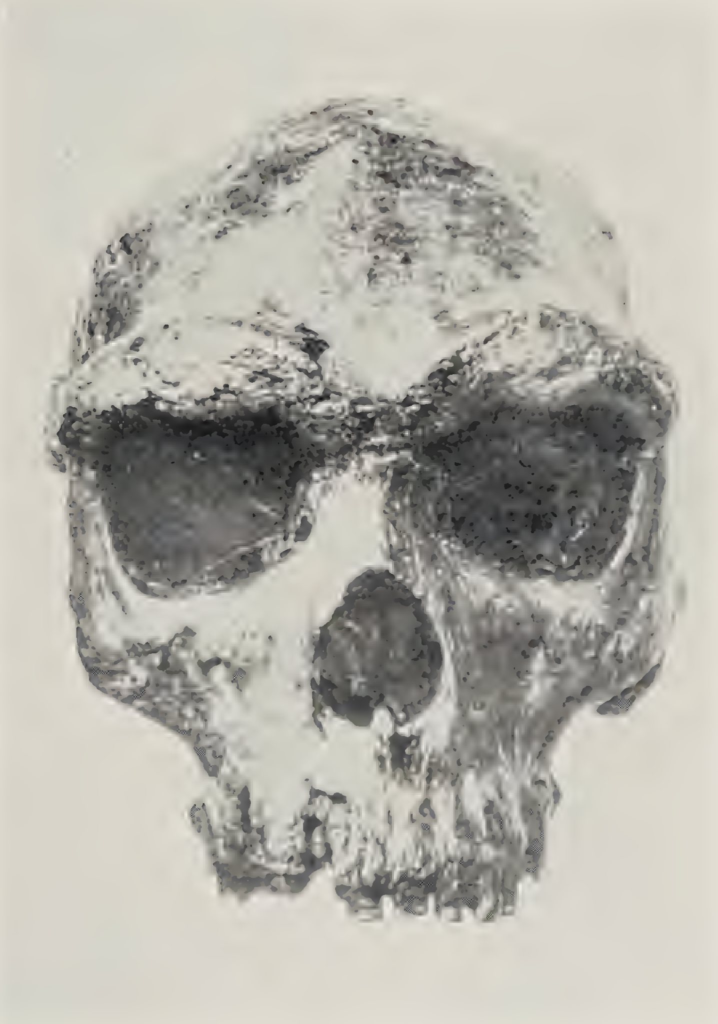
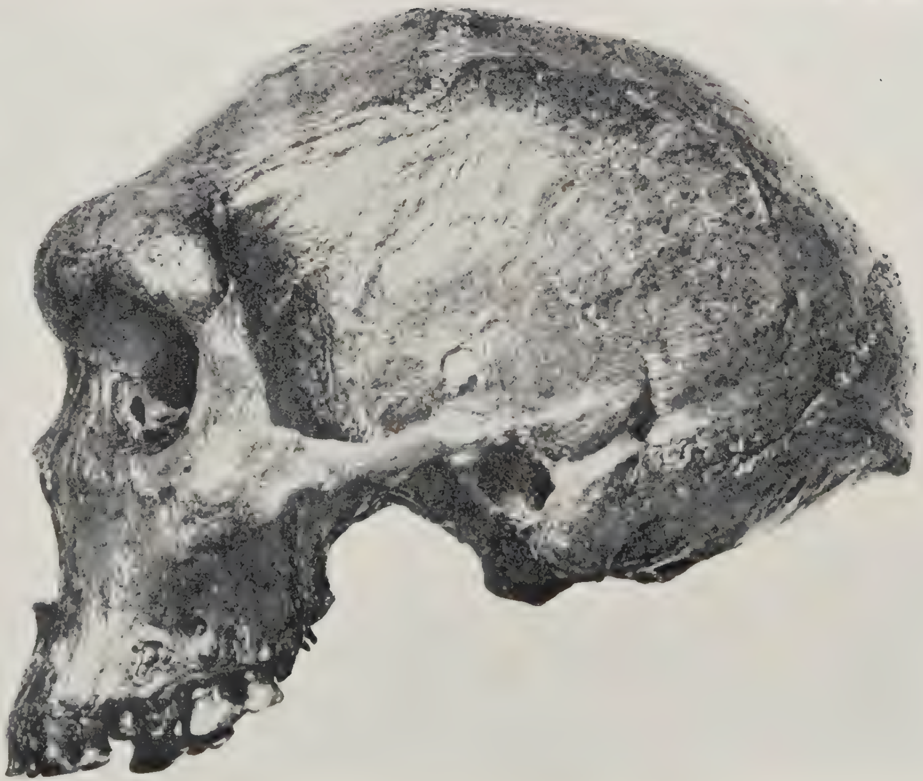
1, 2. Stone implements and characteristically broken animal bones from the Broken Hill cave. (Brought by Hrdlička, 1925; in British Museum.)

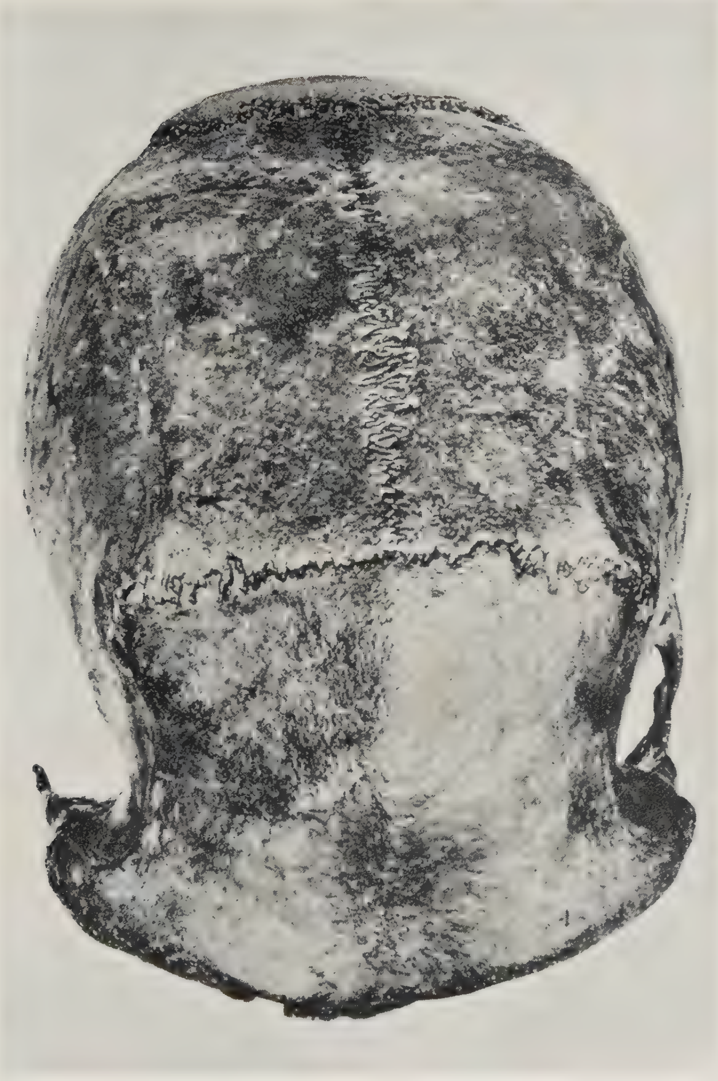
3. Human broken bones from the Rhodesian cave. (Brought by Hrdlička, 1925; now in British Museum.)



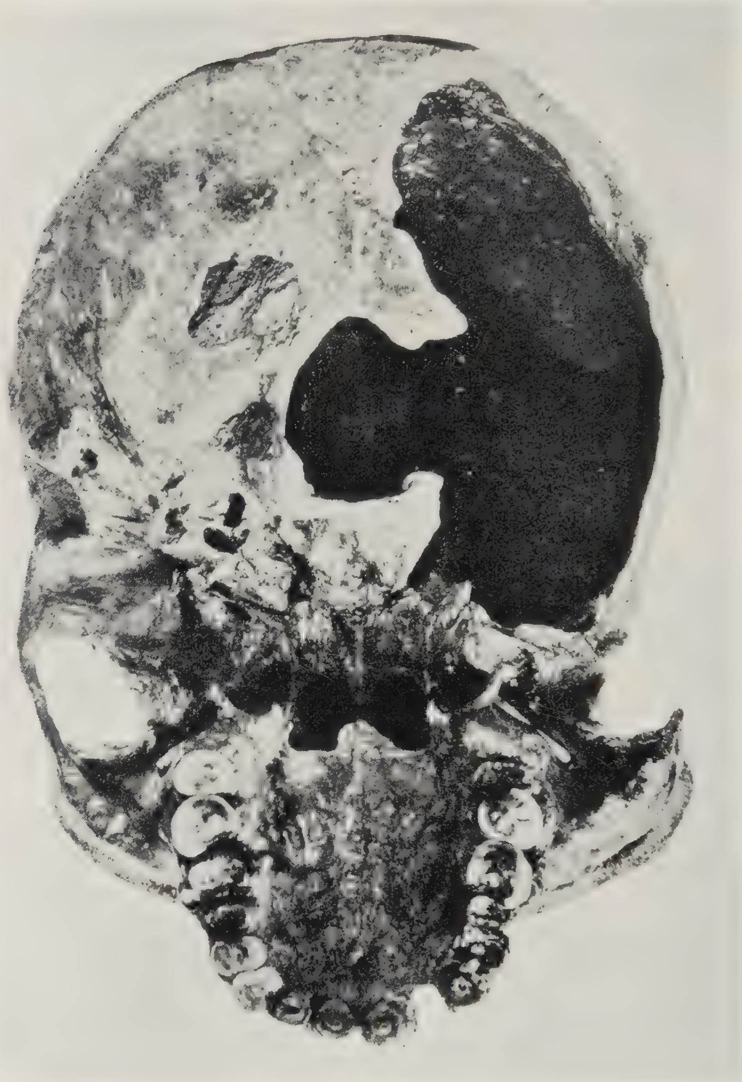
Rhodesian skull, front view.



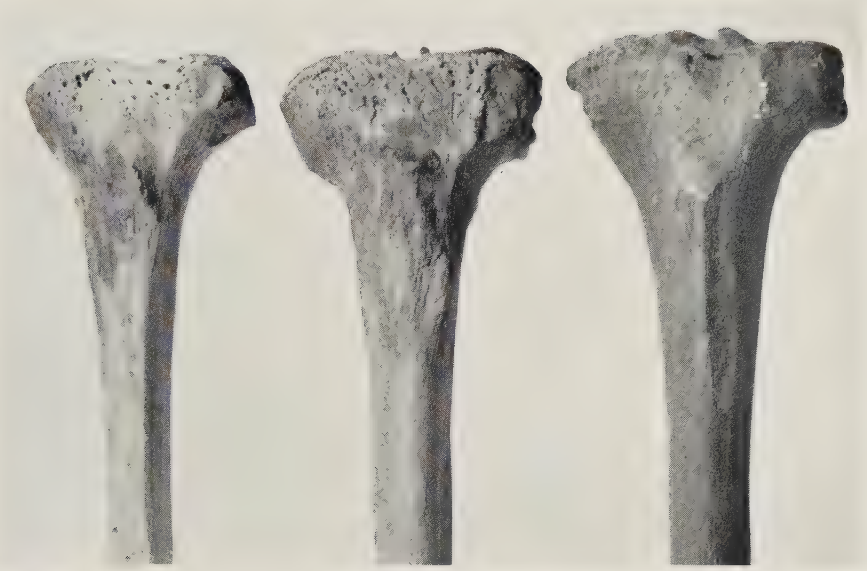
Rhodesian skull, side view. (After Pycraft, 1928.)



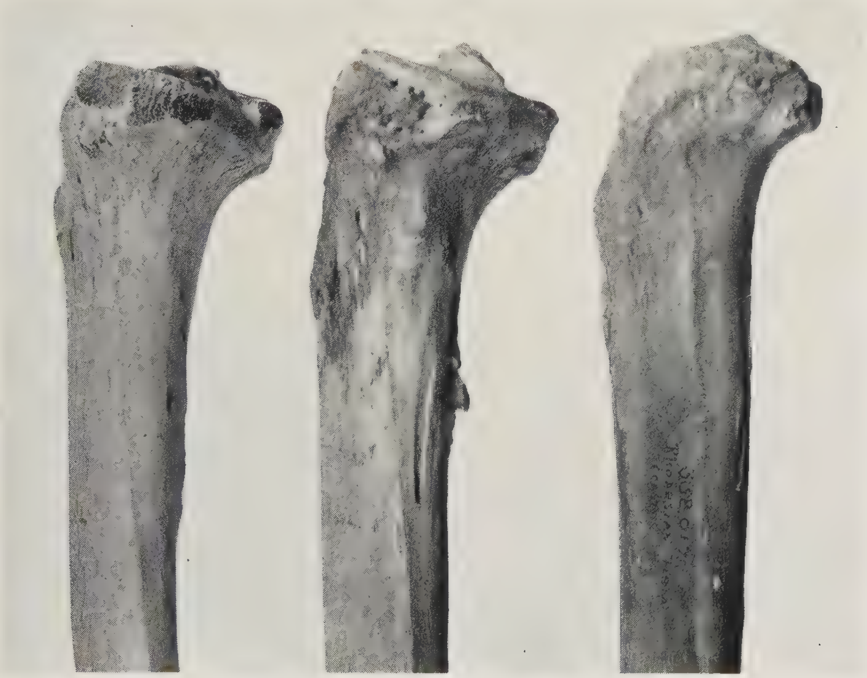
Rhodesian skull, top view. (After Pycraft, 1928.)



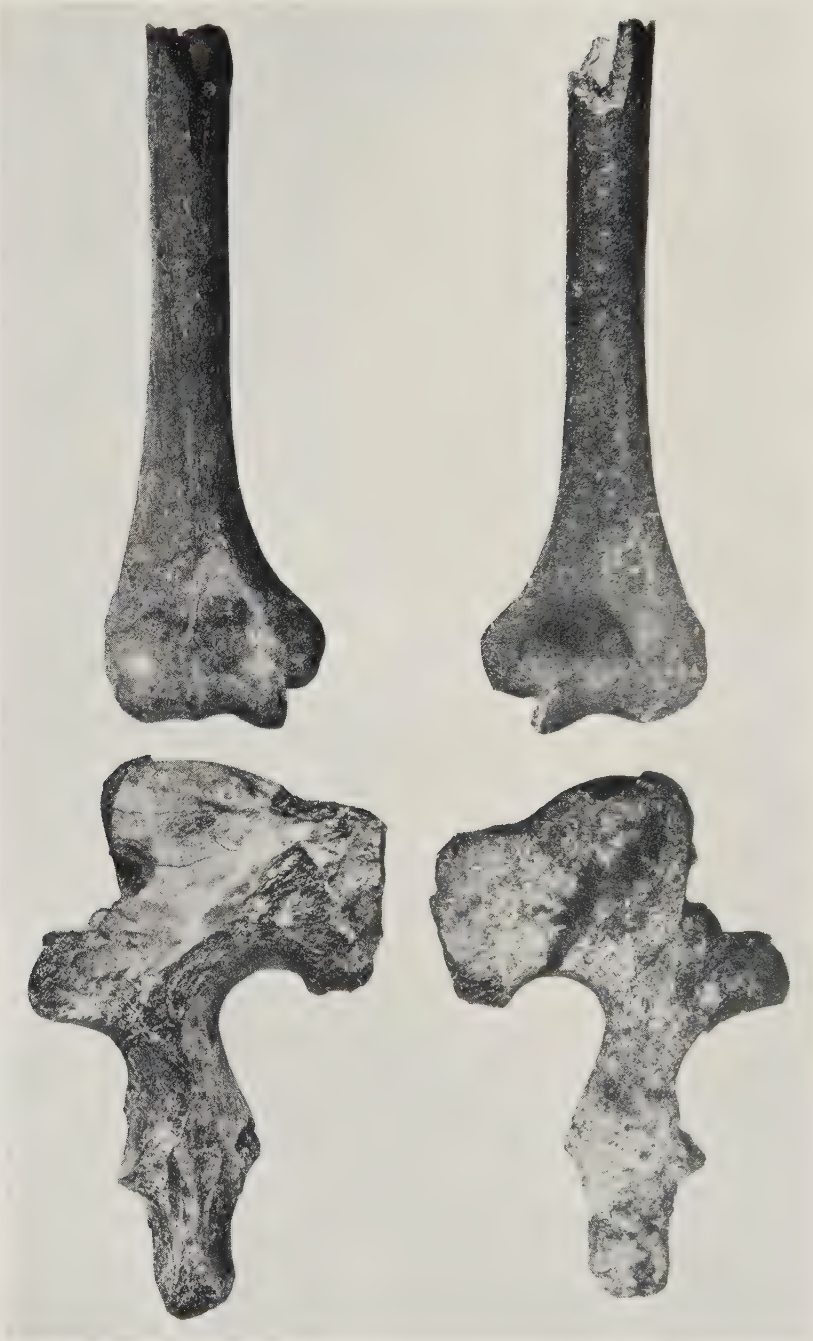
Rhodesian skull, basal view. (After Pycraft, 1928.)



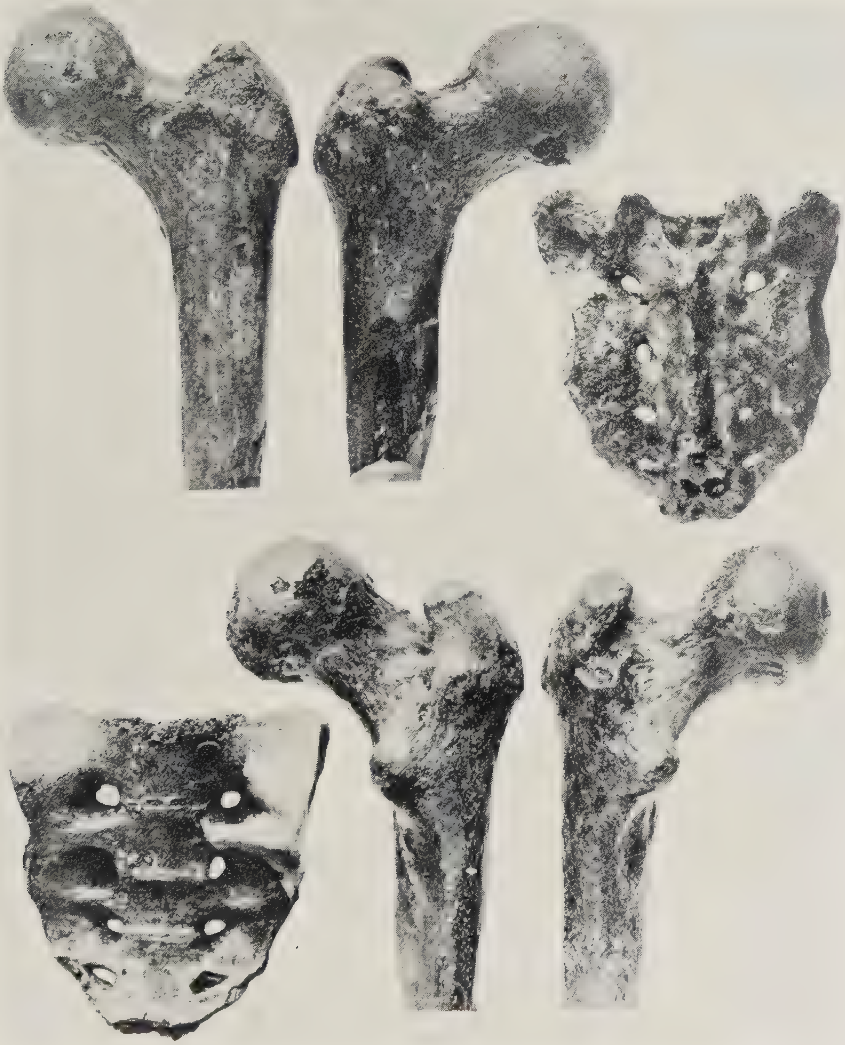
1. Rhodesian tibia (right) and two modern tibiae, all showing a marked development of the tubercle and facet for the attachment of the ilio-tibial. (Hrdlička, U. S. National Museum.)



2. Broken Hill tibia (right) and two modern tibiae (middle and left). Inclination of mesial facet, and other features. (Hrdlička, U. S. National Museum.)



Upper, the humerus from the Rhodesian cave, brought by Hrdlička. (Specimen in British Museum; photograph British Museum.)
Lower, the sacrum from the Rhodesian cave. (After Pycraft, 1928.)



The two femora and the sacrum from the Rhodesian cave. (After Pycraft, 1928.)

Marshall Hole and others, as well as on other material for the opportunity of examining which we are indebted to Mr. White and to Mr. F. G. Colville.

The Rhodesian Broken Hill Mine is situated about 150 miles north of the Kafue River in North-Western Rhodesia. It contains extensive zinc and lead deposits which have a prominent outcrop in the shape of two small hills or "kopjes" rising out of a "vlei" or swampy flat. The surrounding country is chiefly limestone, which is associated, in proximity to the ore-body, with schistose rocks, evidently altered sandy and shaly sediments, together with crushed bands of the limestone itself. There is granite not many miles distant, but the ores do not appear to have any direct connection with an igneous rock; they seem rather to be related to faulting and shearing of the limestone at its junction with the schists. Surface specimens of the limestone are usually somewhat coarsely crystalline, and white or grey in color with few impurities save quartz. Lower down in the workings they are often black or reddish in color and closely resemble the Carboniferous Limestone of Somersetshire. Under the microscope, however, they differ *in toto,* having a foliated structure in even the most compact-looking specimens. It is probable therefore that the sugary appearance of the outcropping rock is due to some form of surface alteration. It cannot be attributed to pressure or contact metamorphism, as it would in that case be just as apparent below ground as it is above. The limestone is highly magnesian and sometimes approaches a true dolomite in composition. No definite silicate minerals can be detected under the microscope.

The feature of the ore-body with which we are now chiefly concerned is the extraordinary accumulation of mammalian bones in No. 1 Kopje. Beautifully crystallized phosphatic minerals have also been found in No. 2 Kopje, but although it would seem a natural inference that they are due to the interaction of the metalliferous solutions with the lime phosphate of bones, none of the latter have been met with. The amount of bones in No. 1 Kopje is enormous. They occur in the central part of the kopje and almost continuously beneath it, below the level of the surrounding flats. It would appear that the bone deposits represent the infilling of a large cavern in the limestone, perhaps with a kind of swallow-hole leading down from the top of the kopje, though there is no actual opening at the present time. It is difficult from the data at present available to determine with any certainty the relative ages of the different layers of bones, but their accumulation must have taken a very long period of time. There are masses of bones almost free from other substances, and there are interspersed muddy layers containing zinc compounds, but free from bones. Much of the material, however, which shows no large bones, yields on disintegration innumerable bones of rats, shrews, birds, etc. The bones are in nearly all cases partly or wholly converted into zinc phosphate (hopeite?). They are therefore truly fossil, the organic matter having disappeared and having been completely replaced by mineral substances. Vughs in the deposit are often lined with magnificent crystals of the rare mineral hopeite and they also show at times more or less dendritic coatings of a substance which at first was taken for amorphous zinc phosphate, but which is rich in vanadium and may really be a calcium vanadate. The new triclinic zinc phosphate "tarbuttite" occurs in No. 2 Kopje with cerussite, hemimorphite, hopeite, pyromorphite and vanadinite or descloizite, and does not seem to be found in the bone deposit.

The bones make up vast accumulations of isolated broken fragments. Whole bones are the rarest exceptions, and are exceedingly difficult to extract even when discovered. There never appear to be a number of bones belonging to the same animal occurring together, as would be the case if they had died naturally on the spot or been accidentally engulfed, in the way suggested for the well-known occurrence at the Winnats, Castleton, Derbyshire. It seems certain that the deposits as a whole represent the materials accumulated during alternating occupations of the original cavern by animals and human beings, with intervening periods when the cave was untenanted probably owing to flooding with water. The animal occupants were such as are found together in the Rhodesian caves of the present day, namely, hyenas and porcupines, no doubt accompanied by owls and bats. Some of the bones show signs of having been gnawed by hyenas, and there can be little doubt that many of them were dragged into the place when it served as a hyena den. Most of the smaller bones are probably to be accounted for in a somewhat similar fashion, the rats, shrews, etc., having formed the prey of owls and the bones having been ejected in the usual pellets after the birds had assimilated the more digestible portions of the bodies. An examination of modern owl pellets entirely confirms this view, as these latter show the same predominance of head and leg bones as do the washings of the Broken Hill deposit. As usual with mammalian remains, lower jaws are particularly prominent. Those parts of the deposit which contain implements, no doubt owe their accumulation in great part at least to human agency, the bones being relics of the food supply of the ancient inhabitants. It may at once be stated that the contemporaneity of the implements and bones is entirely beyond question. Masses of the deposit full of bones when disintegrated by soaking in water, are found to contain embedded implements. These latter are of a rude order and mostly made of quartz, owing of course to the absence of any more suitable material in the vicinity. There seems to be a strong prejudice in England against the genuineness of implements made of quartz, and it may therefore be well to emphasize the fact that some are made of chert brought from a distance, and it may also be well to point out that quartz is a very common material for Bushman implements, which the Broken Hill ones much resemble. Knives, scrapers, and grooved scrapers are the common types. Some of the bones show indications of having been cut previously to their mineralisation, as if to make implements, though no finished bone implements have so far been brought to light. One tibia of a moderate-sized ungulate in the Rhodesia Museum has had a nearly circular hole made in it prior to its replacement by zinc salts. This may be attributed to a wound from an arrow of the Bushman type or it may have been bored with a view to making an implement or ornament; in either case it must be due to human agency.

With regard to the age of the deposit it must represent a long period of time in all, but it will be noted from the subjoined list that nearly all the bones appear to be referable without much doubt to recent species inhabiting the country at the present day. It is probable, however, that some may represent closely allied but really ancestral forms, and this certainly appears to be the case with the species of *Diceros* (rhinoceros) of which two well-preserved bones are now in the Rhodesia Museum. It is unfortunate that we are not in possession of skulls or teeth of this animal, but we think there can be little doubt as to its being new, and it has therefore been thought well to give it a name for convenient future reference.

The mineral condition of the bones and the obvious changes in the physical features of the locality since the deposit was formed are entirely in accord with the idea of its being of very great age from an anthropological point of view. There consequently appears to be every justification for our belief that the evidence affords the strongest presumption of the great antiquity of man in this part of the world, and that further investigations, which we hope shortly to undertake, will reveal even more convincing proof on this head.

LIST OF VERTEBRATE REMAINS

By C. E. Chubb

The following is a list of the vertebrates represented by teeth or bones, and identified as accurately as is possible with the scanty material at my disposal for comparison. " R. M." after a description indicates a specimen in the Rhodesia Museum.

MAMMALIA

INSECTIVORA

An almost complete skull, two or three upper jaws, and numerous lower jaws of shrews. (R. M.)

CARNIVORA

Felis leo, Linn. A right ramus and a few odd teeth.

Felis spp. The canine of an animal about the size of a leopard, and one about the size of *Felis ocreata.* Also two lower jaws apparently belonging to *Felis serval.*

Hyaena sp. A right ramus belonging to a hyena, but it does not agree exactly with *H. crocuta.* (R. M.)

Viverridae. The right ramus of a member of this family about the size of a large genet.

RODENTIA

Tatera sp. Several upper and lower jaws. (R. M.)

Otomys sp. A number of lower jaws showing the characteristic laminated molars and grooved incisors. There are also one or two odd incisors and molars. (R. M.)

Mus. spp. Great numbers of lower jaws and a few portions of upper jaws belonging to several different-sized species. (R. M.)

Bathyergidae. A right ramus without teeth, approximating to *Georychus capensis* in size. (R. M.)

Hystrix sp. A complete ramus and an odd incisor.

UNGULATA

Phacochoerus aethiopicus, Pall. A right upper tusk and a portion of an upper tusk, showing scraping and chipping by human agency. A lower tusk.

Elephas africanus, Blumen. The proximal portion of a humerus, and part of a scapula.

Diceros, Gray. Two complete bones, a left humerus and a right tibia, of a rhinoceros excavated by Mr. Franklin White, were presented by him to the Museum. (R. M. No. 546.) On comparing these with bones of the modern

D. bicornis I find they differ so materially as to warrant their recognition as belonging to a distinct species. This may be known, after the discoverer, as *Diceros whitei*, sp. nov.

Diceros whitei, sp. nov. The humerus of this species differs most remarkably from that of *D. bicornis* in the shape of its distal end. The olecranon fossa is very much narrower than in *D. bicornis*, being 29 mm. in diameter, as compared with 51 mm. for a specimen of the latter. Indeed, the whole bone, although evidently that of a fully adult individual, is smaller and much slighter in proportion to its length, which is 330 mm. from the trochlea to the head of the humerus, while *D. bicornis* measures 358 mm. The tibia, although not differing to the same extent as the humerus, is nevertheless slightly narrower in proportion and a little shorter. This species is evidently a form of rhinoceros smaller and less heavily built than *D. bicornis*. For this reason it is also distinct from *D. simus*, and from *D. simplicidens*, Scott, which is likewise larger than *D. bicornis*. I hope shortly to publish figures showing fully the differences between the species.

Equus sp. Several molars probably belonging to a zebra.

Connochoetes taurinus, Burch. The basal portion of a horn-core.

Strepsiceros strepsiceros, Pall. An imperfect horn-core.

Taurotragus oryx, Pall. Portion of a horn-core.

In addition to the above there are in the Rhodesia Museum a number of bones and teeth of various other antelopes, not identifiable with certainty.

AVES

An incomplete pelvis of a small bird, an ulna and several leg-bones.

AMPHIBIA

The ischial portion of a frog's pelvis; also an astragalus and calcaneum.

FURTHER NOTES

1908.—A second and even more detailed report on the Broken Hill cave soon followed (September 26, 1908). It is a communication by Engineer Franklin White, at that time employed by the Broken Hill Mining Company, to the Rhodesian Scientific Association.[1] The paper, the title of which is "Notes on a Cave Containing Fossilized Bones of Animals, Worked Pieces of Bone, Stone Implements and Quartzite Pebbles, Found in a Kopje or Small Hill Composed of Zinc and Lead Ores at Broken Hill, North-Western Rhodesia" gives in the main the following information:

> The geological formation is limestone with some beds of sandstone conglomerates and phyllites. The country in general is very flat, excepting where the sandstone ridges rise a few feet above the general level. . . . . Around Broken Hill, however, there is a series of kopjes or small rugged hills composed chiefly of ores of zinc and lead, the top of the highest (No. 2) being about 90 feet above

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[1] Proc. Rhodesia Sci. Assoc., Vol. 7, Pt. 2, pp. 13-21, 1908.

the ordinary ground level. . . . . The outcropping zinc and lead ores have been much weathered, forming crevices, rough crests and ledges which at times are sufficient to form lairs for wild beasts, or even to afford a slight shelter for human beings such as Bushmen, but nothing which can be properly called a cave has been found from the outside of these kopjes, neither are there any indications of blocked-up entrances to passages or caverns. Owing to the flat nature of the country, the water in the rainy season stands in numerous pools and can be found in shallow excavations a foot or two in depth. During the dry season the numerous crevices in the limestone afford passage for the water to drain off and the natural water level is then about 18 feet below the ordinary surface. There is therefore an annual rise and fall in the water level underground which will vary according to the rainfall, which is from 23 to 40 inches per annum, the wet months being November to March. . . . . A deposit of fossilized bones, teeth and cores of horns had, however, been found on the Northeast side of the hill when a large quantity of carbonates of zinc, lying on the flank of the hill, was quarried away. The bones were found in a layer of sandy clay about four feet thick, the top being about 3 feet below the surface level.

Beneath the bone layer was a stratum of damp clay, and this rested on ore of the ordinary class. This bone deposit was quite covered over by calamine ore. The bones were highly mineralized, the phosphates of lime being converted into phosphates of zinc. The fragments found were very small, seldom being obtained more than six inches long and were not at all in well defined layers. The northern end of the deposit has not yet been excavated. A lower tunnel, 17½ feet below the others, was driven later on from the southwest to northeast right under the hill, the entrance being from inclines commencing some 20 feet away from the foot of the slope of the hill. At 34 feet from where the tunnel began, the solid ore was replaced by a mixture of rather dull yellow clay in which were embedded numerous fragments of broken bones, teeth and cores of horns of animals and splinters and flakes of white quartz. It was considered advisable to ascertain how much space was taken up by this mixture of clay and a cross-drive or tunnel was made towards the northwest extending for 44 feet. The tunnel reached a face of solid ore dipping steeply to the northwest. No examination was made on the southeastern side of the lower tunnel. A cross tunnel was then driven westwards from the main or surface adit, at 45 feet from the entrance, and at 25 feet the cavity was again reached, the top being nearly level with the tunnel. The width from east to west was thus shown to be some 24 feet. The length, on a line running nearly north and south is at present proved to be 80 feet.

Description of the cave.—This cannot be given very completely at present as the work of excavation is suspended for a time. The northwestern end at the lower level, and the southeastern end at the upper level are exposed, and the position of the northeastern edge can be fairly accurately determined by the points of intersection at the lower tunnel, by the cross-drive, and by the fact that the south shaft is in solid ore. The southwestern edge is still undetermined.

There is clay and earthy material still in the bottom of the cross-drive at the end. There are only a few pieces of bone below a line drawn 4 feet above the floor, or say 13½ feet below the surface level. This may be due to the permanent water level being close by and therefore this portion of the cave would be less frequently occupied. The black earthy and clayey materials forming the lower half of the cross-drive are in distinct layers. In one layer were found some small lumps of sulphide of lead which had apparently been formed there. A section of this end of the cave and its filling shows the following features: The layer, in which bones are most abundant, dips a little to the southeast.

Present roof of cave.—This is composed of a soft, easily disintegrated clay, in which lie pieces of quartz, broken bones of larger animals and innumerable little bones of small animals, some of which have been identified. The roof is thickly studded with beautiful clear white crystals of phosphate of zinc (hopeite). Towards the north another class of small crystals becomes frequent. These are dull red or brown and resemble short moss. The solid face of ore is covered with them. The yellow clay stratum comes within about 1½ feet from the roof and with the aid of a strong light it can be seen that this open space extends for some distance upwards. On top of the clay, crystals of phosphate of zinc are also numerous. In the clay stratum pieces of bone, teeth, etc., are in large numbers and in the side of the tunnel a piece of a large bone some 8 inches wide was found. Below the yellow stratum the filling lies in very distinct thin layers which, however, do not run evenly, but dip in several directions as shown. A thin seam of carbonate or lime crystals runs downwards through this filling which is of a blackish colour and corresponds to the residue which would be left from the decomposition of limestone. The fragments of bone became very scarce towards the bottom of the tunnel. It will be noticed that the filling in of the tunnel has receded or settled down from the roof and back from the end of the cave.

Another noteworthy feature is that the roof at this place is neither ore nor limestone but clay and with it are mingled innumerable small bones and also some pieces of large bones. These facts will be referred to later in the paper. The portion of the cave exposed in the tunnel from the upper drive presents some different features. The roof is limestone, the bone layer is not so thick but the bones are larger. They lie on a bed of soft black débris, are considerably altered, evidently by contact with zinc-bearing solutions and are coated with a thin blackish film which cements them together so firmly that great care is required to separate them from each other. The bones identified as a species of rhinoceros were found here in a position which indicates that they must have been thrown in as it were in a corner. In no instance do the bones lie in such a manner as would indicate that they formed part of an entire animal. They are generally broken, but show no signs of having been gnawed by carnivora. On the other hand there is distinct evidence that the cave was occupied by human beings of a very low type.

Evidences of human occupation.—These can be summarized as follows: Stone implements, chiefly flakes of white opaque quartz, not at all suitable for such purposes, some nevertheless showing distinctly the chipping, cutting or scraping edges and notches. Implements of a close grained reddish stone, one being distinctly serrated. Bones showing cuts or notches, one being chipped into a rough hexagonal form. Pieces of bone, ivory or horn, shaped as if used for digging roots. Large rounded pebbles of quartzite which must have been brought from a distance and were probably used for breaking up marrow bones. The size of some of the bones and position and manner in which they are found makes it very improbable that they are the remains of animals which have died in the cave from natural causes or have been dragged in by beasts of prey.

Formation or origin of the cave and its subsequent filling in.—Although, in view of the little exploratory work done, it is rather premature to advance theories regarding these points, the following suggestions may be put forward as affording a possible explanation. The well defined, nearly vertical face of solid ore which forms the northwest end of the cave may be the result of subsidence caused by the ore or rock below having been dissolved away by underground currents of water, or by thermal springs. This large cavity having been formed, it may have become filled up by clayey matter, bones, etc., washed in from above, and a subsequent subsidence having taken place, a portion of the filling may have remained behind, thereby forming the roof of the present cave. No entrance has been found, although the southern face of the hill has been scraped clean in benches in taking away ore.

The second filling up of the cave may have been as follows: In the yearly rise and fall of water due to the recurring rainy and dry seasons, the fine particles remaining from the disintegration of the limestone would sink down until the bottom was raised to such a level that it would for a great part of the year serve as a habitation for human beings. During each rainy season the rising water would force the inhabitants to retire or occupy the upper part of the cave, and season by season fresh layers of bones, rubbish, stones, etc., would raise the floor still higher.

The entrance may not yet have been discovered, it may be small. It may have been blocked up by falls of rock or covered over by gradual deposition of ore from solutions, as was the case with the bone deposit on the eastern side. It is probable that the entrance was closed up in some way, and that gradually the earth, clay and bones forming the floor or filling settled down and receded from the sides and roof during the recurrent dry seasons. During this period the beautiful crystals of different minerals already referred to, would be deposited from the solutions permeating the mass of ore in the hill. . . . . Many of the animal remains have been examined in the Rhodesia Museum by Messrs. F. P. Mennell, the Curator, and E. C. Chubb, the Assistant Curator, with the result that the following identifications have been made.

Mr. White's communication is followed by Mr. E. C. Chubb's " List of Vertebrate Remains " from the cave (already given), and to this is added a Discussion which brings out or accentuates a number of further points of interest:

Mr. Marshall Hole: What interested me and probably many others in the room most was the evidence afforded on the immense antiquity of man in South Central Africa. I paid a visit to the cave in June of the present year and was struck by the fact that the chipped implements of which I found and brought away several specimens, were confined to a small portion of the cave and that the deepest. I also found a bone which had been perforated probably for use as an ornament and this is now in the Bulawayo Museum.

Father Goetz asked: (1) In what part of the cave were the stone implements found? (2) In what part of the cave were the bones of the extinct animals found? (3) How was the cave formed? Was it not a subterranean cave whose top had fallen in, so that the filling up had come from above?

Mr. Colville: I believe the extinct species was found in the upper level in which the greatest number of large bones are found. The stone implements lay thickest in the lower level anywhere where bones were found but there were also some near the large bones in the upper part. I think it likely that at different periods the cave was occupied by humans and then abandoned for some reason when hyenas and other animals would occupy it, then probably by humans again for a period and so on for ages.

Mr. Chubb: Among the bones examined by me and which have now gone to the British Museum there was one at least which appeared to show evidence of having been gnawed by hyena; I suggest that for a certain period the cave may have formed a hyena den. This would account for a certain amount of the larger bones found in the cave. But to account for the small mammal remains I think that the cave might possibly have provided a roosting place for owls and the pellets of bones which these birds throw up, accumulating for years would yield a great quantity of remains. On the other hand it may be that a large area of surrounding country had been subjected to sudden flooding, in which case all the smaller terrestrial animals would be drowned and carried away by the torrent which might have led into the cave; and the water then draining through would leave the bones behind. It is well known that in the valleys of some of the large South American rivers all the small mammals are often killed in this way.

Mr. Mennell: The paper is of much interest as dealing with the first instance out of Europe and the Mediterranean region of stone implements being found in association with extinct animal remains. Besides the rhinoceros described by Mr. Chubb the jaws of lion and hyena from the deposit did not altogether agree with modern examples and it is quite possible that a number of extinct species will be found.

APPENDIX II

THE FINDING OF THE BROKEN HILL SKULL[1]

THE MYSTERY OF THE GREAT BONE CAVE

The ancient skull which has just recently arrived from Rhodesia and has excited the keenest interest in scientific circles, was unearthed at a depth of 60 feet below water level in the Rhodesia Broken Hill Development Company's mine at Broken Hill, Northern Rhodesia and has been presented by the proprietors of the mine to the British Museum.

No little excitement was caused in the far-away mining camp when it was known that a skull had been found in the mine, and many heated discussions took place among the miners, as to whether it was a large ape's skull or that of a human being. The native laborers were not so interested, however; so after the native foreman had sent the skull to the "white boss" they went on with their digging, and so broke into pieces what would have been a far more important discovery, that of the complete skeleton of this early ancestor of man. It was after the manager of the property had seen the skull that it was decided to put it aside and make a search for further remains, and so we were able to recover a leg bone, a collar bone, portion of shoulder blade, also portion of the pelvis with coccyx attached, and part of a lower jaw, together with various parts of other bones not identified, and most of the pieces of the mineralized cast of the body. The only other large bone found near these human remains was a smashed skull of an animal similar to a lion; also a round stone similar in shape and size to the stones the present-day natives use for various grinding purposes.

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[1] By William E. Harris, The Illustrated London News, Nov. 19, p. 680, 1921.

One can easily imagine a fight to a finish between man and beast in those far-off, dim ages.

The mine, which is at present an open quarry, has been famous for its "Bone Cave" amongst geologists and travellers for some years, and is situated some 650 miles north of Bulawayo. It was at the foot of this "Bone Cave" that the skull and other human bones mentioned were found, constituting the only human remains out of the many hundreds of tons of bones that have been removed during mining operations. Fossilised and partly fossilised remains of elephant, lion, leopard, rhino and hippo, also of antelope and other cattle, together with tons upon tons of bones of small animals and birds, have been found. The writer has stood at a place where this "Bone Cave" has been cut through and has pulled out from the débris various fossilised bones, such as jaw bones, skulls of small animals and teeth all of which were destined to be passed through the smelters to obtain the metals which have replaced the lime of the bones; for chemical examination has shown that the lime has been largely replaced by the phosphates of zinc and lead.

The discovery of this skull is made doubly interesting when the mine and particularly the "Bone Cave" itself are considered. Before mining operations commenced, there stood at this spot a kopje or hill 50 to 60 feet high, with a slight depression in the centre. Mining operations have demolished this hill, and have excavated to the depth of over 90 feet below ground level where the hill stood, and it was at this depth that the skull was discovered. The entrance to the "Bone Cave" was at ground level. One of the early prospectors who visited it before mining operations commenced, has described the cave as being practically filled with débris. After one had crawled over this obstruction and stood upon the floor of the cave proper, it could be seen that bones of various animals were scattered all around. The floor was made of loose débris and fairly dry. The walls and roof were studded with crystalline deposits, which, when lighted up with the rays of a candle or lamp, reflected back the light, making a veritable fairy cavern, whilst bats and owls, disturbed by the unaccustomed lights, flew around, much to the visitors' discomfort.

It is believed that the cave extended some 120 to 150 feet in a horizontal or slightly dipping direction, from west to east. The walls and roof consist of dolomite and zinc silicate, the floor of loose material to a depth varying from 4 to 12 feet, consisting almost entirely of fossilised or partly fossilised remains of animals. Under this carpet of loose material is rock similar to the walls and roof. Thirty feet below the level of the entrance of the cave is the original water level. At about 10 feet below water level, the cave takes a decided dip, and is filled to the roof with loose débris. At 40 to 50 feet the walls have disappeared altogether, and the bones are surrounded with a soft, friable, lead-carbonate ore. As this constituted the main body of the ore around the lower portion of the cave, the theory has been put forward that the zinc in the ore has been leached out by the action of water and so caused a general subsidence which would account for the depression on the top of the original kopje and also for the subsidence of the cave from its supposed original horizontal position.

How did these bones get into this cave and how long have they been accumulating? How did the skull and other bones of the skeleton, the only human remains found there, come to be at the toe of this cave, with tons upon tons of bones above them?

One prominent geologist has suggested that the bones have been placed in the cave by human agency. In amplification, another suggestion has been that the original cavern may have been an extremely ancient mine-shaft which was later used as a dumping pit for animal refuse by a tribe of hunters. But the obviously great antiquity of the skull would discountenance the mining theory, while the enormous quantity (some hundreds of tons) of animal bones and the fact that more than 90 per cent of them are so small that the animals must have been far too little to serve as food for human beings, rather tends to cast doubt on the dumping theory.

Another theory, that these bones have been washed into the cave by periodic floods at the times of rains, cannot stand, as all the bones are loose and not cemented together with mud, as might be expected if they had been washed off the surrounding veldt. Also, where could such masses have come from?

The theory that these animals were engulfed whilst taking refuge from some natural upheaval, such as fire or flood, is likewise untenable, inasmuch as at the toe, where the skull was discovered, apart from the skull only small bones have been found. The larger bones were deposited nearer the mouth, and from their condition must have been a far more recent deposit than that of the skull or surrounding bones.

Truly, the whole subject is an astounding mystery.

THE NEANDERTHAL FAMILY

The skeletal remains attributable to the Neanderthal family already constitute a very imposing lot of material. Their area extends from the middle and southern portions of western Europe to the westernmost parts of Asia. They are dated by the distinctive " Mousterian " culture, so-called after its type-locality at Le Moustier, in southern France, and by the associated bones of extinct mammals belonging to the latter third of the glacial epoch. And they are being added to almost yearly by new discoveries, even though most of these bring forth but a few fragments.

The great interest in the " Neanderthal " family of man lies in the evolutionally decidedly lower characteristics of the remains, and in the seemingly rapid extinction of the variety, not long after the maximum of the last glaciation, upon the supposed advent from somewhere else of *Homo sapiens*. All this is of such importance to prehistory that a somewhat extended critical consideration of the subject is demanded. It will be found at the end of this section. Before this it is necessary to present a rather thorough survey of the evidence presented by the material.

Leaving out of consideration the relatively unimportant and the doubtful items, the remains attributed to the Neanderthal variety of man comprise now (1930) the following:

NEANDERTHAL REMAINS IN CHRONOLOGICAL ORDER OF DISCOVERY

Name of Find	Year of discovery	By whom discovered	Find consists of—	Essential data on discovery	Reported by and when (originally)
Gibraltar....	1848	Laborers...........	Adult female skull, damaged (without lower jaw).	Found accidentally, in a crevice during blasting for an emplacement of a battery.	G. Busk, 1868.
Neanderthal	1856	Laborers...........	Adult male skullcaps, and 13 bones of the skeleton.	Found accidentally in a cave.	C. Fuhlrott, 1857; D. Schaafhausen, 1858.
La Naulette..	1866	E. Dupont..........	Imperfect lower jaw of a young adult woman.	Excavated from undisturbed deposits in Troue de la Naulette, near Dinant, Belgium, under layers of stalagmite alternating with six layers of earth, the two 12 feet in thickness.	E. Dupont, 1866.
Šipka.......	1880	Karel J. Maška.....	Fragment of the frontal part of the lower jaw of a child of about eight years.	Excavated from the "Badger hole," a low lateral extension of the Šipka cave. Lay 1.4 meters deep in undisturbed ash-bed. Freed from a lump of ashes, suffering thereby probably the loss of a tooth and some small pieces of bone (Maška).	Wankel, 1880; Schaafhausen, 1881 and 1883; R. Virchow, 1882; Maška, 1886.

NEANDERTHAL REMAINS IN CHRONOLOGICAL ORDER OF DISCOVERY—CONTINUED

Name of Find	Year of discovery	By whom discovered	Find consists of—	Essential data on discovery	Reported by and when (originally)
Spy No. 1 and No. 2	1886	Marcel de Puydt and Maximin Lohest.	Two skeletons, males, adult	Excavated from Terrace in front of a cave, 6 and 8 meters distant from entrance, 4 meters deep.	J. Fraipont and M. Lohest, 1887.
Bañolas (Gerona, Spain)	1887	Lorenzo Roura	Lower jaw	In hard travertine, about 15 feet from surface.	Cazurro, 1909; Harlé, Pacheco and Obermaier, 1912.
Malarnaud (Ariège)	1889	F. Regnault	Lower jaw, adult female	In ancient clay, with bones of extinct animals, capped by a layer of stalagmite.	H. Filhol, 1889.
Krapina (Croatia)	1895, 1899, and 1905	K. Gorjanović-Kramberger.	Parts of over 20 skeletons (adult and sub-adult, both sexes).	Excavated from the fillings of an old rock-shelter, with remains of fire, bones of extinct animals, and stone implements.	Gorjanović-Kramberger (various dates).
Le Moustier (Dordogne)	1908	O. Hauser	Skeleton of an adolescent male.	Excavated from an accumulation of cultural debris of Mousterian age, in lower rock-shelter, at Le Moustier.	O. Hauser and H. Klaatsch, 1909.
La Chapelle (Corrèze)	1908	Abbés A. Bouyssonie, J. Bouyssonie, and L. Bardon.	Skeleton (male, middle-aged).	Burial (formal) in a depression dug in the marly soil of the floor of a cave.	A. and J. Bouyssonie and L. Bardon, 1908; M. Boule.
Jersey (Channel)	1910	MM. Nicolle and Sinel	13 teeth (from both jaws) of one skeleton.	Cave accumulations, near an ancient hearth.	R. Marett, 1911; A. Keith, 1911.

NEANDERTHAL REMAINS IN CHRONOLOGICAL ORDER OF DISCOVERY—CONTINUED

Name of Find	Year of discovery	By whom discovered	Find consists of—	Essential data on discovery	Reported by and when (originally)
La Quina (Charente)	1908–21	Henri Martin.......	Skeleton of an adult (female(?) 1911); lower jaw (1912); skull of a child (1921); fragments of several skeletons (different dates).	Partly in ancient mud-bed of the near-by stream (adult skeleton, etc.); partly in kitchen refuse and debris (child skull, etc.).	H. Martin, 1911–27.
a Ferrassie (Dordogne)	1909, 1910, and 1912	Peyrony...........	6 skeletons (2 adults—a male, a female—and 4 children).	At base of accumulations in a shallow rock-shelter.	Capitan and Peyrony, 1909, 1912.
Ehringsdorf (Weimar)	1914, 1916, (and later)	Quarrymen.........	2 lower jaws, remains of a child's skeleton, portion of a thigh-bone.	Deep in hard travertine (and intercalated layer).	G. Schwalbe, 1914; H. Virchow, 1920.
Galilee......	1925	F. Turville-Petre....	Fragments of the skull of a young adult, including the frontal-bone.	Cave, at the base of undisturbed paleolithic layer, 6½ feet below the modern floor-level.	F. Turville-Petre and Arthur Keith, 1927.
Ehringsdorf (Fischer's Quarry).	1925	Quarrymen.........	Broken vault of an adult skull.	Deep in hard travertine.....	F. Weidenreich, 1927.
Gibraltar....	1926	Miss D. A. E. Garrod.	Skull of a child of about ten years of age.	Rock-shelter, with Mousterian culture.	Abbé Breuil (shelter); Miss D. A. E. Garrod (prelim. notes), 1926.
Near Rome.. (Italy)	1929	Workmen..........	Adult female skull, without lower jaw.	Cave breccia, with Quaternary fauna.	S. Sergi, 1929.

THE NEANDERTHAL SKULL AND BONES

Among the most famous of the skeletal remains representing early man are unquestionably the imperfect but highly characteristic specimens known as the Neanderthal skull and bones. This important find more than any other has aroused scientific men to an intense realization of the earlier phases of human evolution. The skull and to some extent also the other parts of the skeleton stand morphologically far below those of any existing type of man, being correspondingly nearer to lower primates; and their name has been deservedly taken to designate the entire early phase of mankind of which the skeleton is, as is now well known, a prototype.

The skull, with most if not all the rest of the skeleton, was found in August, 1856.[1] The bones were dug out accidentally by two laborers from an old cave located in the right wall of the Neander gorge, not far from its upper entrance. The gorge and the valley north of it have remained strangely but little known to anthropology. The writer had the good fortune to visit them in 1927.[2] Lying between Düsseldorf (11 km.) and Elberfeld (16 km.), they form an unexpectedly beautiful bit of scenery, sunk beneath the level of a somewhat raised cultivated plain, and constitute one of the most interesting natural formations in western Germany. They have for generations been the favorite spots for school and other excursions. The valley and gorge were eroded in the limestone formations that underlie the surface by the small stream Düssel and its two branches.

The gorge is said to have originally been called simply " Gesteins " (rocks). It was later named for Joachim Neander, a poet and song composer of the German Reformed Church, who loved to visit the gorge and probably the cave that eventually gave the skeleton, between the years 1674-1679. From about 1850 the term " Neanderthal " has been extended to both the gorge and the valley, as well as to the little village and railroad station at the edge of and within the valley. Today this whole beautiful depression constitutes the " Natural Reservation Neanderthal," which comprises the whole triangle between Erkrain, Mettmann, and Gruiten.

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[1] In many publications the date is erroneously given as 1857.

[2] A very grateful acknowledgment of the facilities extended, original information and valuable illustrations, is due to the gentlemen of the Rheinish-Westfälishe Kalkwerke, Dornap; to Herr Peter Herring, supervisor of the quarrying works of the company; and to H. Lickoff, Löbbecke Museum, Düsseldorf.

The gorge was bound by high rough cliffs of Devonian limestone, and since the early fifties of the last century it has been subjected to extensive quarrying that still proceeds. In the summer of 1856 the destruction reached the so-called "Feldhoffer Grotte," a somewhat extensive cave located in the right cliff not far from the "Ravenstein" (isolated high rock still preserved). The mouth of the cave lay about 110 feet from the right bank of the stream and 60 feet above its level.

According to local accounts the cave was in two parts; and as the laborers were clearing the loam out of the smaller they uncovered a human skeleton. Some parts of this were broken and the bones were thrown out together with the earth; later, however, upon the urging of the owner of the quarry after he was told of the find, the workmen collected 14 pieces of the skull and skeleton, and these were given soon after into the hands of Dr. Fuhlrott of Elberfeld.

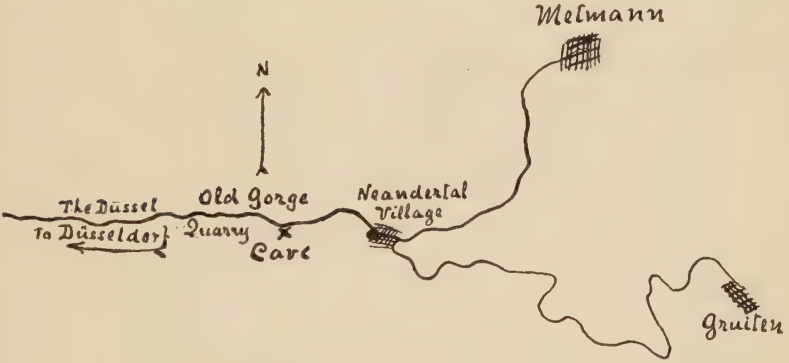

FIG. 13.—A sketch of the "Naturschutzgebiet Neandertal," the vicinity of the Neanderthal find.

The bones obtained by Dr. Fuhlrott comprised the skullcap, the femora, humeri, ulnae, right radius, portion of the left pelvic bone, portion of the right scapula, piece of the right clavicle, and five pieces of ribs (pls. 29-33).

Soon after their discovery the skeletal remains of the Neanderthal man received the attention of Prof. D. Schaaffhausen, of Bonn, who on February 4, 1857, made a preliminary report upon them at the meeting of the Lower Rhine Medical and Natural History Society, of Bonn.[1] At the general meeting of the Natural History

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[1] Verhandl. d. naturhist. Vereins der preuss. Rheinlände und Westphalens, Vol. 14. Bonn, 1857. Also "Zur Kenntniss der ältesten Rassenschädel," Müller's Archiv, p. 453 *et seq.*, 1858.

Society of Prussian Rhineland and Westphalia, at Bonn, on June 2, 1857, Dr. Fuhlrott himself gave a full account of the locality of the find and of the circumstances under which the discovery was made.

The principal details of Dr. Fuhlrott's[2] report were as follows:

> A small cave or grotto, high enough to admit a man and about 15 feet deep from the entrance, which is 7 or 8 feet wide, exists in the southern wall of the gorge of the Neanderthal, as it is termed, at a distance of about 100 feet from the Düssel and about 60 feet above the bottom of the valley (fig. 3). In its earlier and uninjured condition this cavern opened upon a narrow plateau lying in front of it and from which the rocky wall descended almost perpendicularly to the river. It could be reached, though with difficulty, from above. The uneven floor was covered to a thickness of 4 or 5 feet with a deposit of mud, sparingly intermixed with rounded fragments of chert. In the removing of this deposit the bones were discovered. The skull was first noticed, placed nearest to the entrance of the cavern; and further in were the other bones lying in the same horizontal plane. Of this I was assured in the most positive terms by the two laborers who were employed to clear out the grotto, and who were questioned by me on the spot. At first no idea was entertained of the bones being human; and it was not till several weeks after their discovery that they were recognized as such by me and placed in security. But, as the importance of the discovery was not at the time perceived, the laborers were very careless

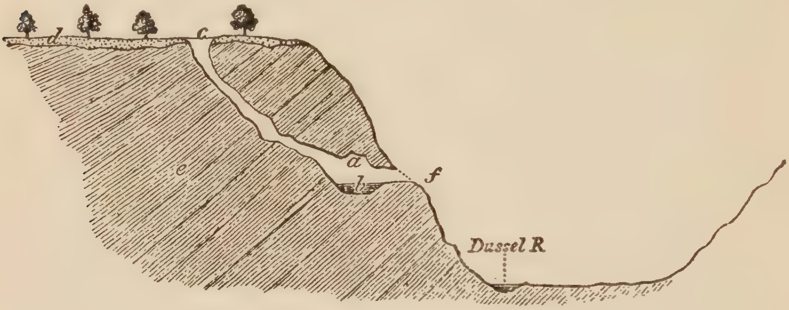

FIG. 14.—Section of the Neanderthal Cave near Düsseldorf. (After Lyell.)
a, Cavern 60 feet above the Düssel, and 100 feet below the surface of the country at *c.*
b, Loam covering the floor of the cave near the bottom of which the human skeleton was found.
b, c, Rent connecting the cave with the upper surface of the country.
d, Superficial sandy loam.
e, Devonian limestone.
f, Terrace, or ledge of rock.

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[2] *Ibid.* Correspondenzblatt No. 2. The above follows G. Busks's Translation of Schaaffhausen's "On the crania of the most ancient races of man," Nat. Hist. Review, April, 1861. The main publication by Fuhlrott on the Neanderthal find appears in the monograph: "Der fossile Mensch aus dem Neanderthal und sein Verhältniss zum Alter des Menschengeschlechts," pp. 1-78, Duisburg, 1865.

in the collecting and secured chiefly only the larger bones; and to this circumstance it may be attributed that fragments merely of the probably perfect skeleton came into my possession.

Fuhlrott held that the Neanderthal bones might be regarded as "fossil," by which he possibly meant not merely mineralized, but also as belonging to a form of humanity no more existing. A little later Prof. Schaaffhausen arrived at the following conclusions:[1]

> First, the extraordinary form of the skull was due to a natural conformation, hitherto not known to exist even in the most barbarous races. Second, these remarkable human remains belonged to a period antecedent to the time of the Celts and Germans, and were in all probability derived from one of the wild races of northwestern Europe, spoken of by Latin writers, and which were encountered as autochthones by the German immigrants. And third, it was beyond doubt that these human relics were traceable to a period at which the latest animals of the Diluvium still existed; though no proof of this assumption, nor consequently of their so-termed fossil condition, was afforded by the circumstances under which the bones were discovered.

In 1860 the Neanderthal gorge was visited, in company with Fuhlrott, by Lyell, the English geologist and paleontologist, who made a sketch of the locality (fig. 14.) and we are given the following information:[2] Since the discovery of the bones—

> the ledge of rock, *f*, on which the cave opened, and which was originally 20 feet wide, had been almost entirely quarried away, and, at the rate at which the work of dilapidation was proceeding, its complete destruction seemed near at hand.
>
> In the limestone are many fissures, one of which, still partially filled with mud and stones, is represented in the section at *a c* as continuous from the cave to the upper surface of the country. . . . .
>
> There was no crust of stalagmite overlying the mud in which the human skeleton was found, and no bones of other animals in the mud with the skeleton; but just before our visit in 1860 the tusk of a bear had been met with in some mud in a lateral embranchment of the cave, in a situation precisely similar to *b*, figure 3, and on a level corresponding with that of the human skeleton. This tusk, shown us by the proprietor of the cave, was 2½ inches long and quite perfect; but whether it was referable to a recent or extinct species of bear, I could not determine.

Following the early notices concerning the Neanderthal cranium, and before other specimens of similar nature, such as the Spy, Gibraltar, and others became known, an extensive controversy arose as to the real significance of the find. Virchow,[3] and after him others, were at first inclined to look upon the skull as pathological; to Barnard Davis[1] its sutures appeared to show premature synostosis; while Blake[2] and his followers regarded the specimen as probably proceeding from an idiot. But there were also those, such as Schaaffhausen, Broca, and others, who from the beginning saw in the cranium (the other bones received at first but little attention) not any pathological or accidental monstrosity, but a peculiar, theretofore unknown type of ancient humanity. Then gradually new examples of this same early type appeared in different parts of Europe, under circumstances which steadily strengthened the claim of the whole class to geological antiquity; and when eventually a thorough comparative study of the Neanderthal remains was carried out by modern methods and in view of new knowledge, the cranium and bones were definitely recognized as representing, in a normal and most characteristic way, a most interesting earlier phase or variety of mankind, our later Quaternary predecessor or close relative, *Homo neanderthalensis*. The credit for deserving work in this field is due especially to Prof. G. Schwalbe, of Strassburg, whose numerous publications on the early forms of human remains in Europe are well known to every anthropologist.[3]

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[1] *Loc. cit.*

[2] Lyell, Sir Charles, The geological evidences of the antiquity of man, 4th ed., p. 80 *et seq.*, London, 1873.

[3] Virchow, R., Untersuchung des Neanderthal-Schädels. Zeit. f. Ethnol., Vol. 4, Verhandl. Berl. Ges. f. Anthr., etc., pp. 157-165, 1872.

The remains of the Neanderthal skeleton are preserved in the Provincial Museum at Bonn, where, due to the courtesy of the director, Professor Hans Lehner, the writer was enabled to examine the originals and later have them photographed.

THE SKULL

The skull (pls. 29-31) is gray in color, with large mud-brownish or gray-sepia patches on the outside, and whitish gray to whitish brown on the inside. It is decidedly heavy and much mineralized. It is plainly non-pathological. The sagittal suture has evidently closed earlier than it ordinarily does in the civilized modern man, but this must have taken place after the brain ceased to influence the cranial vault, for it resulted in no perceptible deformation. The coronal suture is obliterated up to the temporal ridges, while the lambdoid is still patent. Similar conditions to these are not seldom met with in the skulls of persons beyond the fiftieth year of life, and if not attended by scaphocephaly or other consequent deformation, cannot be regarded as abnormal. The serration of the lambdoid suture is decidedly simpler than in modern human skulls.

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[1] Davis, J. Barnard, The Neanderthal skull, etc., London, 1864.

[2] Blake, C. Carter, On the alleged peculiar characters and assumed antiquity of the human cranium from the Neanderthal. Journ. Anthrop. Soc., London, Vol. 2, pp. 139-157, 1864; also Mem. Anthrop. Soc., London, Vol. 2, p. 74, 1866.

[3] Those especially worthy of mention in this connection are: Ueber die Schädelformen der ältesten Menschenrassen, mit besonderer Berücksichtigung des Schädels von Egisheim. Mitteilungen der philomathischen Gesellschaft in Elsas-Lothringen. 5, Jahrg., Vol. 3, 1897; and Der Neandertalschädel, Bonner Jahrbücher, Heft 106; 72 Stn. 1 Tafel, 1901.

The facial and basal parts are lacking. The vault shows very good dimensions in length and breadth, but is strikingly low, and the bones are considerably thicker than in the white man of to-day, so that the brain cavity was only moderate.

Besides its lowness the vault is characterized by a very decided protrusion of the whole supraorbital region. The supraorbital torus or arch formed through this protrusion is heavier than in any other known example of the *Homo neanderthalensis*. The line from glabella to the naso-frontal articulation is relatively extensive and passes considerably backward besides downward, indicating a very marked depression at the root of the nose, not unlike that which is present in the adult gorilla. Due also to the forward extension of the supraorbital arch, the upper parts of the planes of the orbits face very perceptibly downward, while in present man they face somewhat upward or approach the vertical. The remarkable extent of the protrusion of the supra-orbital region may be judged by the fact that the horizontal distance from the most prominent point of the glabella to the nearest point on the ventral surface of the lower frontal region measures 3 cm. The frontal process descends deep between the orbits and is very stout.

The forehead is low and also slopes markedly backward, nevertheless it presents a moderately-well defined convexity. The sagittal region is oval from side to side, much like that in man of to-day; the occiput, however, is marked by a relatively high location of the crest and other peculiarities. The outline of the vault, as looked at from above, is a long ovoid. The thickness of the frontal bone at the eminences is 8.5 mm.; of the left parietal, along a line 1 cm. above the squamous suture, 6 to 8 mm.; these measurements are about one-third greater than those of the skull of an average modern European.

The principal external dimensions of the cranium, taken carefully with two separate instruments, were found to differ slightly from some of those recorded, but agree closely with those of Schwalbe. They are shown in the table on the following page.

The lowness of the vault, in the absence of the basion, was measured, as seen on the antero-posterior outline of the skull, from a line connecting the most prominent point of the glabella and the inion to the highest point of the vault. This feature is shown especially strikingly by the "calotte index," or percental relation of the two dimensions. In modern crania the distance from the *g-i* line to the highest point of the skull measures invariably materially more, and the index is invariably much higher, than in the Neanderthal skull.

MAIN MEASUREMENTS OF THE NEANDERTHAL SKULL
(TAKEN ON THE ORIGINAL)

Dimensions	Neanderthal		Corresponding dimensions in a modern male white skull
	Schwalbe	Hrdlička	
	cm.	*cm.*	*cm.*
Glabella-inion length	19.9	....	18.7
Greatest length (glabella ad max.)	....	20.1	18.8
"True" length (discounting the excess of the supraorbital torus) to inion	18.6	....	....
"True" length, max.	....	18.8	18.8
Greatest breadth	14.7	14.7	14.7
Cranial index (with Schwalbe's length)	*73.9*	....	....
Cranial index (with length max.)	....	*73.1*	....
Cranial index (with "true" length to inion (Schwalbe))	79.0	....	....
Cranial index (with "true" max. length (Hrdlička))	....	*78.2*	*78.2*
Brain cavity: Length max.	17.5[1]	near 17.2	17.4
Breadth max.	13.7[1]	near 13.5	13.8
Index	*78.3*	near *78.5*	*79.3*
Height (from glabella-inion line to vertex)	8.05	....	10.5
Calotte index $\frac{\text{H} \times 100}{\text{Gl.} = \text{In. L.}}$	*40.4*	....	*56.1*
Thickness of skull: At glabella	....	near 30 mm.	14 mm.
of parietals (squammae)	....	6 to 8 mm.	4 to 6 mm.
of frontal, at eminences	....	8.5 mm.	5 to 7 mm.
Nasion-bregma diam.	11.6[2]	11.7[2]	11.0
Bregma-lambda diam.	10.4	10.3	11.5
Lambda-inion	5.2	....	....
Lambda-mid-point of occipital crest[3]	....	5.4	6.4
Diam. frontal min.	10.7[4]	10.7[4]	9.8
Diam. frontal max.	....	12.3	12.4
Index $\frac{\text{D. fr. min.} \times 100}{\text{D. fr. max.}}$	....	*87.0*	*79.0*

---

[1] These dimensions, it would seem, must have been taken on a cast; they do not harmonize with the thickness of the skull.

[2] This diameter is larger than in modern skulls because of the carrying forward of the nasion by the excessive supraorbital protrusion (torus).

[3] The crest turns upward in its mid-portion; if it formed a regular arc the diameter from lambda to the mid-point (inion) would be 5.6 cm.

[4] Large because of the great thickness of bone here.

The actual height of the latter is but 8.05 cm. (Schwalbe), the index *40.4*. One hundred and seven recent adult human skulls of various derivation gave heights of from 8.40 to 11.70 cm., and indices of from *52* to *68*.[1]

The internal capacity of the skull has been estimated by Schaaffhausen at 1,033 cc., by Huxley at 1,230 cc., and by Schwalbe at 1,234 cc.

The brain which filled the skull was lower and narrower and slightly more pointed than the human brain of to-day, approaching in these features more the anthropoid form. The right frontal lobe was slightly larger and longer than the left, and the whole right hemisphere was slightly longer than that of the opposite side. In the present man it is generally the left hemisphere which is the longer, but this exception in the Neanderthal man is not necessarily of any special significance.

The long and other bones of the skeleton (pls. 32, 33), so far as preserved, show many features of anthropological inferiority, demonstrating plainly that not merely the skull, but the whole body of the Neanderthal man occupied a more or less lower evolutionary stage than that of any normal human being of the historic times. Yet there is much also that connects closely with later and present man.

OTHER PARTS OF THE SKELETON

The humerus.—The two humeri, right and left, do not appear at first to belong to the same person; the right is much stronger in every particular, and of somewhat different conformation, the differences occurring in the inner condyle, in the evident damage to the articular facets on left; in the neighborhood of coronoid fossa; in the olecranon fossa—much larger on left (2.7 x 2.1 cm.); in the form of shaft; and in the deltoid tubercle which is much better developed on right. Also color unlike. But the left bone belongs to an ulna with an old injury to head and both have suffered from subdevelopment as well as in the formation of the articular parts.

The shape of the shaft in both bones nears the prismatic, but the antero-medial and external surfaces are decidedly convex, especially in the right well-developed humerus. This is a condition that could hardly be duplicated in recent bones. There is no perforation of the olecranon fossa. There is a marked notch (demi-foramen) in each epicondylar border, lower down than usual with the epicondyloid notch or foramen today; quite similar in the two bones. Processus supracondyloideus—no trace on left; on right bone low rugosity.

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[1] Schwalbe, G., Studien über Pithecanthropus erectus Dubois. Z. Morph. und Anthrop., Vol. 1, pp. 43-45, 1899.

The damage on left does not seem to have been a complete fracture, but more a crushing one in the outer part of the articular facet and anterior and outer part about the coronoid fossa, the injury taking place probably when the subject was quite young.

The ulna.—Left ulna: head was broken early in life, at the same time that the humerus was injured, but was well healed and joint was useful. Body quite straight, shape prismatic, with slight indication of external (fourth) border and slightly concave on both anteromedian and antero-lateral surfaces.

Right ulna: more than one-half missing; in upper third was bent backwards more than left; bones of about same strength.

Radius.—Right bone alone. Pronounced arching outward in middle third; otherwise not extraordinary.

The clavicle.—The piece of right male clavicle shows that the bone was longer than in modern man but of submedium thickness. It differs from modern bones also in the form of the shaft, which proximally is clearly prismatic, and in the distal extremity beyond the coracoid tuberosity, where the bone was relatively thicker but decidedly narrower than are modern male clavicles. There is no deltoid tubercle, and the anterior curvature in this place is more pronounced than in modern bones.

The scapula.—Present, a portion of the right bone, including the glenoid cavity. Original notes: The bone is strong but not excessively so. The glenoid cavity seems to be inclined somewhat more backward than in modern bones. The dorsal surface of the axillary border shows a somewhat marked secondary ridge for the insertion of teres minor. For comparative notes see Boule's Memoir on the La Chapelle Remains, 1913, pp. 121, 124.

The ribs.—Present, five pieces of ribs. Some of the fragments are stout, one measuring 17 mm. in breadth and 11 mm. in thickness. One piece of a rib shows a slight circular thinning of the bone (noticed also by Bardeleben), probably representing an old fracture.

The pelvis.—The pelvis, with other portions of the skeleton, has been studied especially by Klaatsch (see bibliography). The writer's original notes, which quite agree with those of Klaatsch but point out some additional features, are as follows:

Present, the larger part of the left os innominatum; missing, the pubic parts. The bone is powerful, especially in region of ileopectineal line and at the sacral articulation. Ilium rather flat, high, and bent more outward from the i-p line than in modern pelves.

Greater sciatic notch masculine, deep, not narrow. Breadth of bone between anterior border of the greater sciatic notch and the anterior border of the cotyloid cavity less than in recent bones. Notch anteriorly between the anterior-inferior spine of the ilium and the iliopectineal eminence broader and deeper, and the eminence itself more pronounced, than in modern ilia. The articular part of the acetabulum is decidedly less extensive antero-superiorly, and forms in consequence

MAIN MEASUREMENTS OF THE NEANDERTHAL ARM BONES
TAKEN ON THE ORIGINALS

	Neanderthal				Means in 965 American Whites (misc.) Hrdlička	
	Schwalbe[1]		Hrdlička[2]			
	R.	L.	R.	L.	R.	L.
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Humerus: Length max.	31.2	....	31.0	(Injury)	32.66	32.40
Head: Transverse diam.	4.8	....	4.8	....	....	....
Sagittal diam.	4.65	....	4.7	....	....	....
At middle: Antero-post. (or min.) diam.	....	....	1.90	(1.7)	1.89	1.86
Lateral (or max.) diam.	2.55	....	2.55	(2.05)	2.31	2.21
Index	....	....	*74.5*	*(82.9)*	*81.9*	*84.1*
Shape of shaft at middle	....	....	near type I[3]	....	....	....
Epicondylar, distal end, breadth max.	6.3[4]	6.4[4]	6.45	6.3	....	....
Ulna: Length max., estimated	27.1[5]	Injury (23.7)	....	....	....	....
At middle: Antero-post. diam.	....	....	....	1.35	....	....
Lateral diam.	....	....	....	1.45	....	....
					(526 in	divids.)
Radius: Length max.	23.8	....	23.9	....	24.01	23.82
Radio-humeral index	....	....	*77.1*	....	*73.63*	*73.65*
At middle: Antero-post. diam.	1.15	....	1.20	....	....	....
Transverse diam.	1.65	....	1.55[6]	....	....	....

---

[1] Der Neanderthalschädel, Jahrb. Ver. Altertsfr. Rheinh., 1901, Heft 106.

[2] Original measurements, 1912.

[3] Regular prismatic, with the medial-anterior and lateral surfaces convex.

[4] Probable transposition of figures. The right bone is throughout larger. The excess of the right epicondylar breadth over the left is well shown also in the casts.

[5] Probably excessive.

[6] The slight differences between the measurements by the two observers are doubtless due to slight differences in method. The cast, which as usual is slightly larger than the original in all dimensions, measures 1.25 x 1.60. The measurements I take are: for the transverse—the maximum; for the antero-posterior—the bone so placed that its sharp medial border is midway between the branches of the sliding compass.

considerably less of a circle, than in recent ossa innominata; and the shape of the fossa acetabuli is different. The postero-superior border of the obturator foramen differs also rather materially from that in recent bones; it presents a marked triangular point above the cotyloid notch, and is markedly obtuse in its lower half. Other minor peculiarities of the bone appear to fall within the range of its present variation.

The femur.—The Neanderthal femora differ markedly from those of the average present man. Their distinctive features could not collectively be duplicated today, in some instances not even individually.

The head is large and more globular than in modern man. The neck is stout and rather short, and the angle it forms with the shaft is less oblique than in most recent femora. The connecting bridge of bone between the great trochanter and the neck is stouter than in most recent bones; the trochanteric fossa is larger than in modern man. The trochanter minor is prominent and located more mesially than in most modern femora; this is especially the case on the right. The sub-trochanteric flattening and bellying is but moderate, especially on the right. The upper third of the shaft shows a distinct bend outward (medial convexity inward); this is either absent or but slightly represented in normal recent femora. The whole shaft shows a marked uniform arching forward, reaching from the level of the trochanter minor to the condyles; such curve, to such a degree, is but rarely found in normal modern bones. The gluteal insertion is marked by a somewhat irregular oblong blunt ridge, pronounced in its upper portion which reaches to and upon the great trochanter; it would be hard to duplicate such a condition in modern femurs. The linea aspera is relatively but slightly developed; this is rare in strong male modern bones. The shape of the shaft at the middle is intermediate beween cylindrical and oval. The popliteal space in both bones is very distinctly convex except in the lowermost portion, which is flat to very slightly concave; the fullness (convexity) of the upper two-thirds of the space, to this degree, could hardly be duplicated in modern femora; it recalls the femur of the Pithecanthropus, though the convexity of the latter is even greater.

The lower end of the femur is very distinctive: the lateral condyles rise decidedly higher above the mesial than is the case in modern femora; the anterior portion of the intercondylar notch is markedly concave, especially on the right, while in modern femora its outline from side to side is convex-concave-convex.

THE NEANDERTHAL FEMORA

(Originals)

	Schwalbe		Hrdlička		400 American Whites (misc.) Hrdlička	
	r. *cm.*	*l.* *cm.*	*r.* *cm.*	*l.* *cm.*	*r.* *cm.*	*l.* *cm.*
Femur: Length, bicondylar	43·9[1]	44·05	43·7	43·9	44·79	44·81
Stature, estimated[2]	....	....	164·0	....	....	....
Humero-femoral index	....	....	*71·4*	....	*72·7*	*72·0*
Head: Diam. max.	....	....	5·35	5·35	....	....
Diam. infero-superior	5·3	5·4	5·35	5·35	....	....
Diam. transverse (antero-post.)	(5·05)	5·2	damaged	5·25	....	....
Neck: Diam. max.	....	....	4·05	3·95	....	....
Diam. min.	....	....	2·9	2·8	....	....
At middle: Diam. antero-post.	3·1	3·1	3·05	3·05	....	....
Diam. transverse	2·95[3]	3·05[3]	2·9	3·0	....	....
Mean diam.	....	....	2·98	3·02	2·89	2·90
Index of strength $\left(\frac{\text{Mean diam.} \times 100}{\text{Femoral-length}}\right)$	....	....	*68·1*	*68·9*	*64·4*	*64·5*
Circumference	9·4	9·6	9·4	9·6	....	....
Below trochanter minor:[4]						
Diam. antero-post	3·0	2·95	....	....	....	....
Diam. transverse	3·4	3·55	....	....	....	....
Subtrochanteric flattening:						
Diam. min.	....	....	2·8	2·7	2·69	2·71
Diam. max.	....	....	3·4	3·7	3·25	3·26
Index	....	....	*82·4*	*73·0*	*82·8*	*83·3*
Lower end: Epicondylar breadth max.	8·5	8·5	8·8[5]	8·8[5]	....	....
Condyles: Diam. max. lateral:						
Mesial condyle	3·35	3·20	....	....	....	....
Lateral condyle	3·05	3·05	....	....	....	....
Diam. antero-post.:						
Mesial condyle	....	....	6·9	7·0	....	....
Lateral condyle	....	....	7·35	7·5	....	....
When bones lie on the condyles, the lateral rises above the mesial by	....	....	7 mm.	8 mm.	....	....
In same natural position head of left bone is higher from the horizontal than the right by	....	....	....	3 mm.	....	....
Inclination of the diaphysis to the vertical	84°	85°	....	....	....	....
Angle of neck	119°	118°	....	....	....	....

[1] In the posthumous work of Schwalbe on the Pithecanthropus femur, Z. Morph. u. Anthrop. Vol. 21, p. 354, 1921, the mean length of the Neanderthal femur is given as 43.8 cm., which corresponds exactly to the mean length of the writer's measurements.

[2] Using the quotient *26.8*, obtained by Hrdlička on bodies of 100 male Americans.

[3] The figures are printed reversed, namely 3.05 and 2.95, which is clearly an error; the left shaft is the stronger (see circumference), and the casts of the bones confirm the matter.

[4] These are not the same measurements as those that follow; the writer takes, as the most useful, the minimum and maximum dimensions of the flattening.

[5] Here is a rather material difference between the measurements of Schwalbe and the writer's which must be due to some difference in method. The writer's measurements represent the maximum obtainable epicondylar breadth taken by the stouter branches of an accurate compass glissière.

The medial superior surface of the mesial condyle, which is generally fuller to convex in modern femora, is concave in both of the Neanderthal bones (especially in the right); the outlines of the fossae of the condyles differ somewhat from those in modern femora. The anterior surface of the lower portion of the shaft, slightly over 3 cm. above the middle of the border of the articular surface, shows plainly on each side, but especially well marked on the left side, a patellar fossa close to 12 mm. in length but somewhat less in breadth; such fossae are very rare in recent femora.

CONCLUDING REMARKS ON PARTS OF THE SKELETON OTHER THAN THE SKULL

The long and other bones of the Neanderthal skeleton, as far as preserved, show many features of anthropological difference from and inferiority to the corresponding parts of recent man, indicating plainly that not merely the skull, but the whole body of the Neanderthal man occupied a lower evolutionary stage than that of any normal human being of historic times.

The bones in general indicate a powerful musculature, and broad and strong chest, combined with a somewhat submedium stature.

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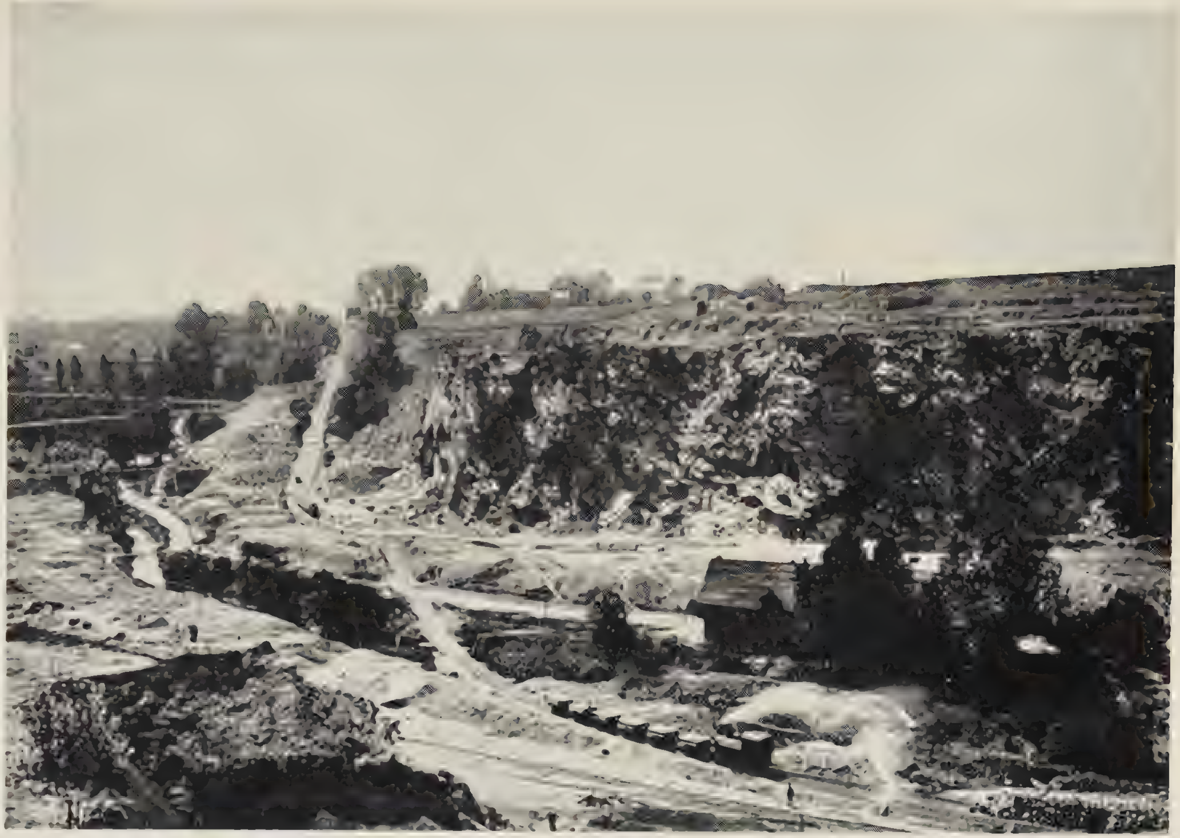
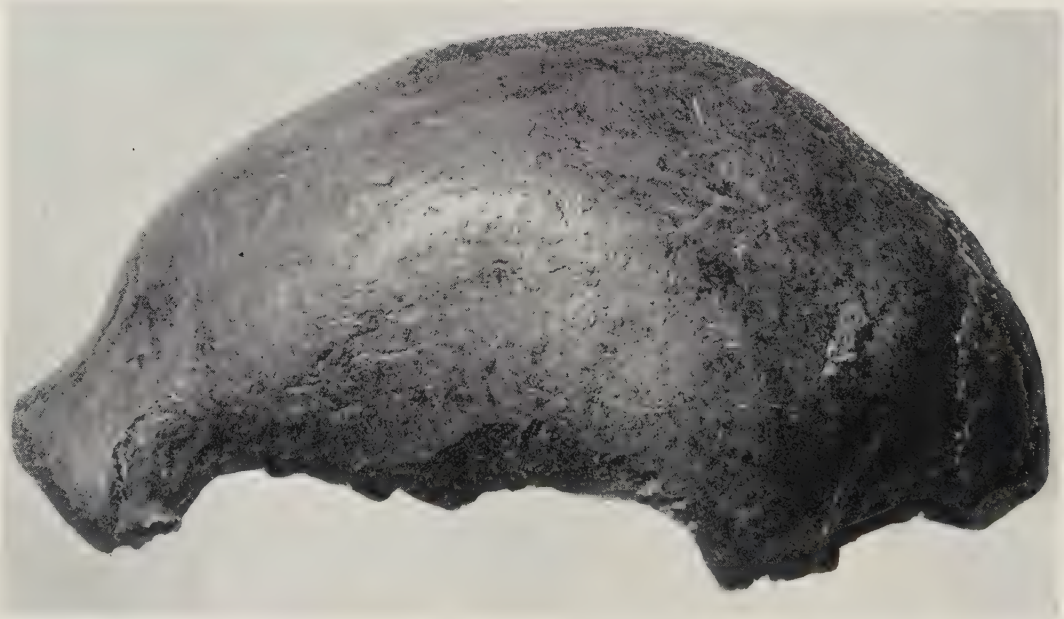
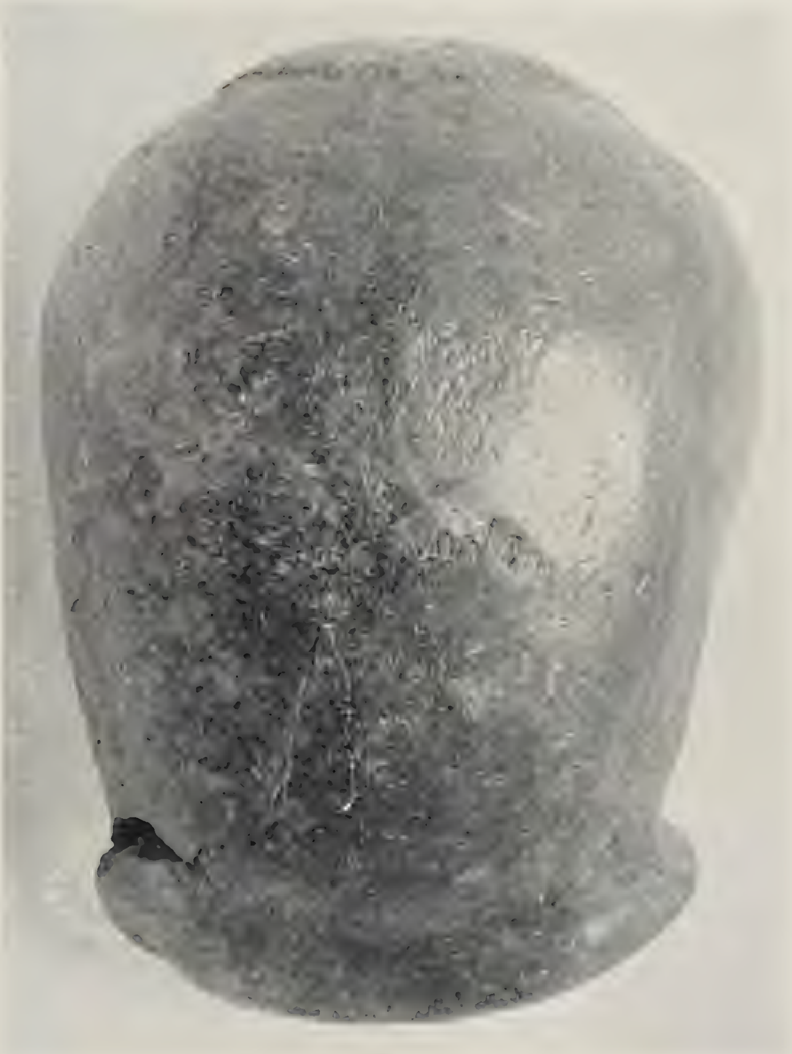


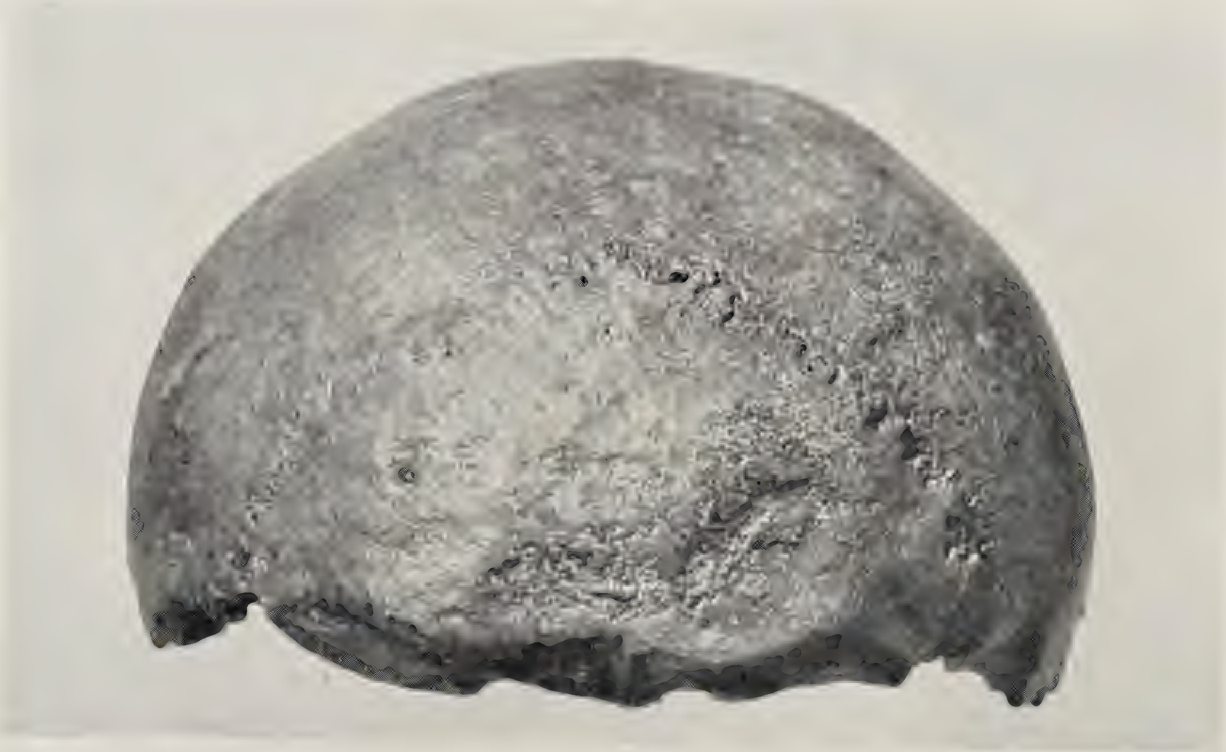
The left cliff of the Neanderthal, recently. The Feldhoffer cave, in which the ancient skeleton was discovered, long since blasted away, lay in front of the left half of the face of the cliff. (Photograph donated by the "Rheinisch-Westfalische Kackwerke," Dornap, Germany.)



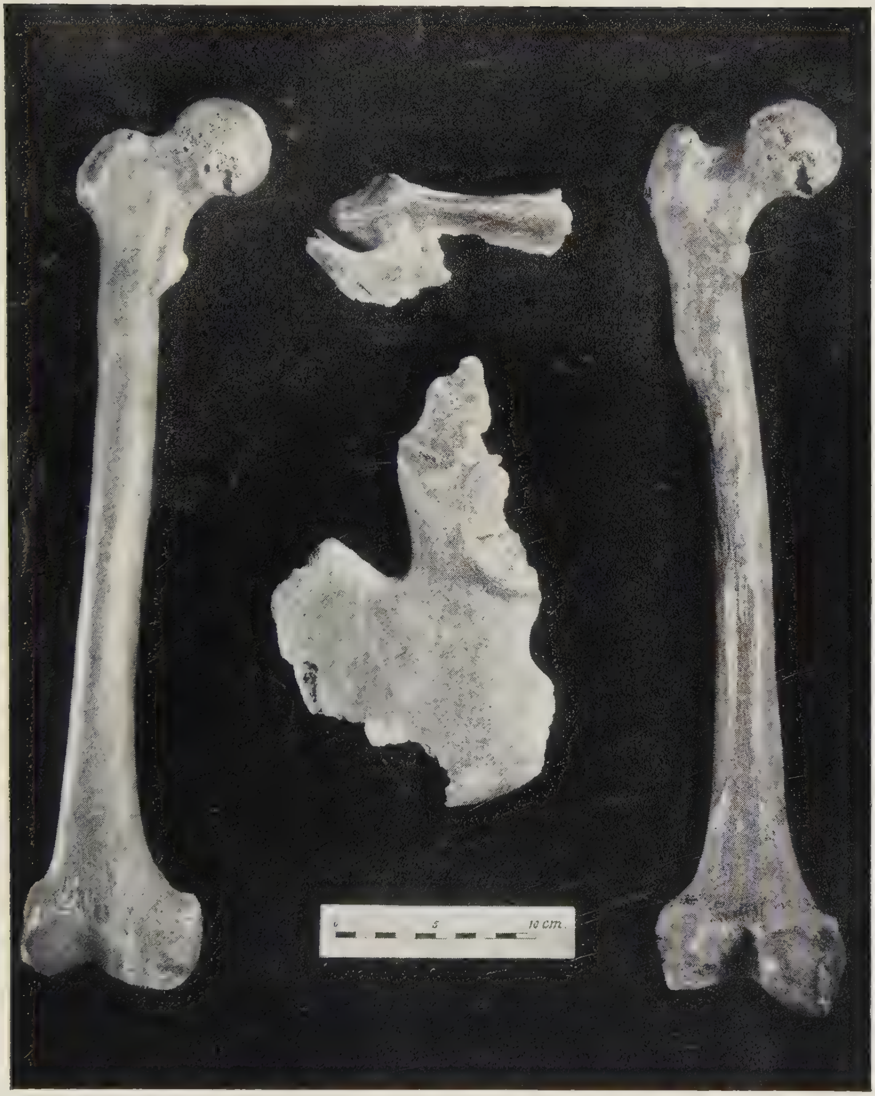
The Neanderthal skull, side view. (Photographed from the original.)



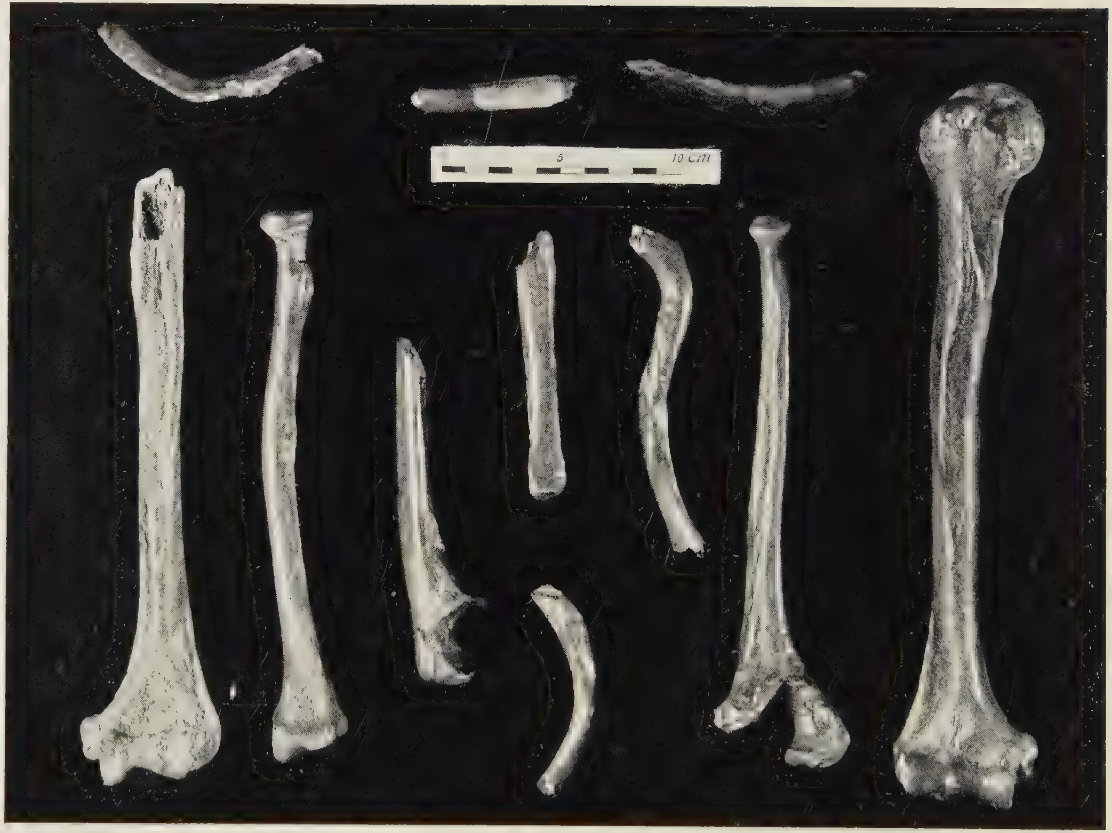
The Neanderthal skull, top view. (Photographed for the Smithsonian Institution from the original.)



Neanderthal skull, back view. (Photographed from the original.)



The femur, scapula and ileac bone of the Neanderthal skeleton. (Photographed for the Smithsonian Institution from the original.)



Bones from the upper limbs and thorax of the Neanderthal skeleton. (Photographed for the Smithsonian Institution from the original.)

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THE SKULL OF GIBRALTAR

This very valuable specimen is preserved in the Museum of the Royal College of Surgeons, England, where, thanks to the courtesy of the curator, Sir Arthur Keith, the writer has been able to examine it repeatedly and have it photographed.

The history of the specimen is, regrettably, somewhat defective. The first mention of it occurs in Falconer's Paleontological Memoirs,[1] in 1868, where, on page 561 of Volume 2, speaking of various anthropological and other finds at Gibraltar, the author says:

> One of the human skulls yielded by the rocks many years since appears to us to point to a time of very high antiquity. In fact, it is the most remarkable and perfect example of its kind now extant. In the absence of a properly organized museum no record exists of the precise circumstances under which this interesting relic was found, and that it has been preserved at all may be considered a happy accident; it has cost us much labor, and with but partial success, to endeavor to trace its history on the spot where it turned up.

Besides this, Falconer remarks in a letter to a relative,[2] referring to the skull: "It is a case of a very low type of humanity—very low and savage and of extreme antiquity—but still man. . . . ."

Taking all the available data into consideration,[3] it appears that the skull was accidentally discovered as early as 1848, therefore eight years before the Neanderthal cranium made its appearance, in the "Forbes Quarry, situated on the north base of the Rock of Gibraltar." According to Keith,[4] it was "quarried out of the terrace under the north face of the rock," a terrace formed of solidified breccia, consisting of the débris of weathering of the limestone cliff and fine wind-blown sand. The part of the terrace where the cranium lay was possibly in former times the floor of a cave. Part of a cave still exists behind the site of the discovery, and this was explored in 1911 by Duckworth, but without results. It is certain that the skull showed, and to some extent presents to this day, a hard stony matrix adhering to its surface and filling its cavities. Broca, to whom we owe the first descriptive account of the specimen,[5] says that it was taken out of a "very compact and adherent gangue," from which it was disengaged with much difficulty. The photographs published with Broca's account show still very noticeable remnants of the stony matrix (see also pl. 34).

The skull was presented to the Gibraltar Scientific Society by Lieut. Flint, then its secretary, but for many years received no scientific attention. In 1862 it came to England, with the collections from the

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[1] Falconer, Hugh, Paleontological Memoirs and Notes, 2 vols., London, 1868; also Quart. Journ. Geol. Soc. London, Vol. 21, p. 369, 1865.

[2] *Op. cit.,* p. 561, footnote.

[3] Compare Keith, A., The early history of the Gibraltar cranium. Nature, pp. 313-314, 1911.

[4] Ancient Types of Man, p. 121, 1911.

[5] Broca, P., Crânes et ossements humains des cavernes de Gibraltar. Bull. Soc. d'Anthropol. Paris, 2d séries, Vol. 4, p. 154, 1869.

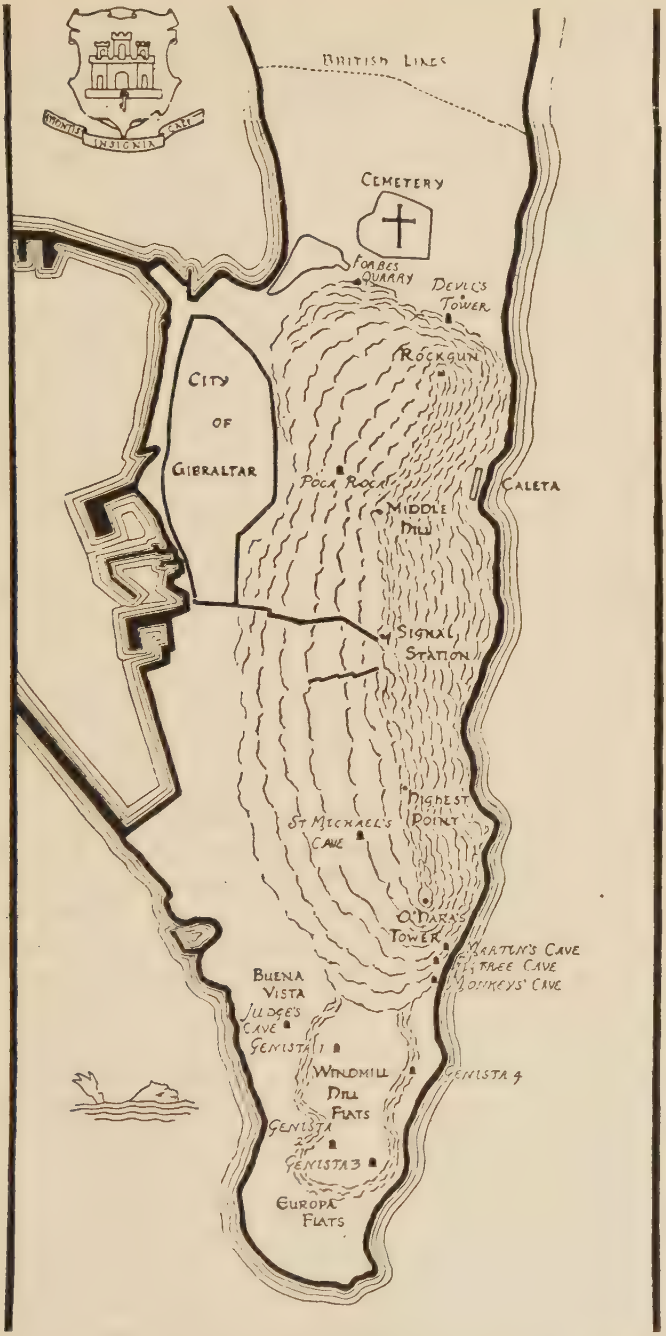
BRITISH LINES
MONTIS INSIGNIA CALPE
CEMETERY
FORBES QUARRY
DEVIL'S TOWER
ROCKGUN
CITY OF GIBRALTAR
POCA ROCA
CALETA
MIDDLE HILL
SIGNAL STATION
HIGHEST POINT
ST MICHAEL'S CAVE
O'HARA'S TOWER
MARTIN'S CAVE
FIG TREE CAVE
MONKEYS' CAVE
BUENA VISTA
JUDGE'S CAVE
GENISTA 1
WINDMILL HILL FLATS
GENISTA 4
GENISTA 2
GENISTA 3
EUROPA FLATS

FIG. 15.—The Rock of Gibraltar: sites of both Forbes Quarry (skeleton, 1848), and Devil's Tower (skeleton of child, 1926). (After Miss Garrod, 1928.)

Gibraltar caves, and was studied to some extent by Busk and Falconer. The latter, perceiving how much it differed from recent human skulls, proposed to refer it to a distinct variety of man, *Homo colpicus,* after Calfé, the old name of Gibraltar. Finally in 1868 Busk presented the cranium to the Museum of the Royal College of Surgeons of England, where it is still preserved.

The first descriptive account of the specimen was published, as mentioned above, by Broca, but at that time the adhering stony matrix prevented any attempts at accurate measurements. Subsequently it received attention by Huxley, De Quatrefages and Hamy, and later from Macnamara, Klaatsch, Schwalbe, Sollas, Sera, and Keith, as well as the writer. It is a very remarkable specimen which, even though the geological and paleontological evidence relating to its antiquity is imperfect, does not allow for one moment of any doubt as to its representing an early human form; and its characteristics are such that it is now universally regarded as a representative, possibly a very early one, of *Homo neanderthalensis.*

The cranium is grayish-white to yellowish in color, and is considerably mineralized and heavier than normal. The stony matrix has been so far removed that all important determinations and measurements which the defective state of the bones permit may now be made. Fortunately the facial region, the frontal bone, and most of the right side of the skull, including the back, are relatively well preserved; the top of the vault on the other hand shows a large defect, and the left parietal, temporal and sphenoid parts, together with much of the base, are lost. With all the defects, sufficient of the skull remains to permit of a number of valuable determinations on the skull and as to the brain, and also a fairly correct reconstruction.

The aspect of the face is semi-human, apish. The mid-portion from the glabella downward protrudes forward more than in normal skulls, as a result of which the planes of the orbits as well as the planes of the malars slope more outward and backward than they do in modern crania. The line from the nasion to the point of intersection of the external and fronto-malar suture gives in a modern female skull an inclination from the horizontal of 11°; in the Gibraltar cranium the same inclination is close to 20°.

Other very striking features of the face are the relatively huge (for a female) supraorbital arch; the very large orbits; the stoutness of the medial process of the frontal bone; the complete absence of suborbital (canine) fossae; the broad nose; and the dental arch with long teeth. The supraorbital arch measures nearly 12 cm. in breadth, and from approximately 12 to over 15 mm. in thickness above the orbits. It does not greatly protrude forward, as it does in the male Neanderthal skulls, nevertheless it represents a true and rather huge torus, such as is wholly unknown in recent crania. The orbits are very large, irregularly circular in outline. They are separated by the stout median process of the frontal, with a large glabellar swelling and space above; the bones forming their external boundary are markedly broader than in modern skulls. The orbital borders, especially the mesial half of the inferior ones, are more or less dull and stout. The nasal bones are broad, not long, and moderately arched from side to side. The nasal aperture is strikingly broad, but not negroid; its lower borders were evidently fairly sharp, and there are evidences of a good-sized spine. The side walls of the aperture and the nasal bones are very perceptibly thicker than they are in modern skulls. A remarkable feature which gives the face its characteristic appearance is the fullness, to mild convexity, of the suborbital (canine) fossae and of the nasal processes of the maxilla. All these parts look as if inflated from behind.

The upper alveolar process was broad and originally probably fairly high. It has suffered from absorption and damage so that the roots of the remaining teeth in the anterior half of the arch are nearly fully exposed. The teeth, though considerably worn off, appear very long. A very interesting condition is the absence of the two median incisors. As there is no sign of any decay, and the alveolar process shows a characteristic absorption notch at this place, it would seem that the two teeth must have been lost long before the death of the individual, and that presumably through some violence. This condition recalls forcibly the ceremonial knocking out of these incisors (and sometimes also other teeth) in the negro, Australian, and other primitive peoples.

Added to these facial peculiarities of the skull is its low and sloping forehead. The ensemble presents a picture of phylogenetic inferiority which, taking into consideration the fact that this is unquestionably the skull of a female, is not quite equalled by any other specimens of Neanderthal origin thus far discovered; though it is true that the facial features are preserved in only a few of the specimens belonging to this great period.

The vault of the skull is especially noteworthy on account of its lowness, and through a peculiar formation of the occiput. The posterior parietal and upper occipital region shows a broad mild flattening ending in a medium occipital eminence, which gives the region an impression of breadth and submedium height. Much the same characteristic is found also in other Neanderthal skulls.

The temporal bones, judging from that on the right side, most of which is present, were remarkably small. The lines of attachment of the temporal muscles and fascia were about as in modern skulls. The mastoid was decidedly smaller than it is in modern crania. The external auditory meatus is also of very moderate size. The vault viewed from above is ovoid in shape. The cranial bones, particularly the frontal and the parietals, are rather thick, the occipital being perceptibly thinner and nearer in this respect to modern skulls. The base, though largely damaged or missing, shows a number of points of special interest.

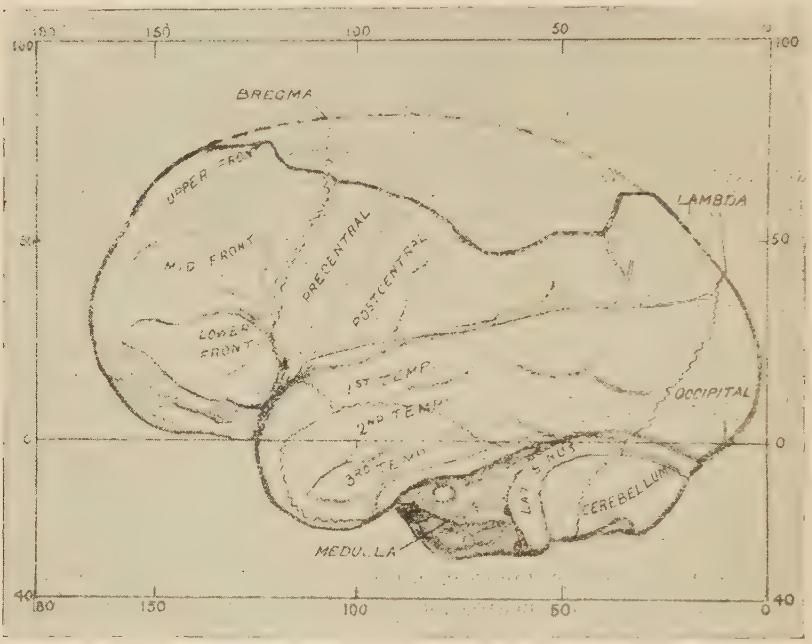
180
150
100
50
0
100
50
0
40
BREGMA
UPPER FRONT
MID FRONT
LOWER FRONT
PRECENTRAL
POSTCENTRAL
LAMBDA
1ST TEMP
2ND TEMP
3RD TEMP
OCCIPITAL
LAT SINUS
CEREBELLUM
MEDULLA

Fig. 16.—Profile drawing of the brain cast of the Gibraltar skull. It represents the smallest known brain of the extinct Neanderthal race. (After Keith.)

The broad dental arch is nearly horseshoe-shaped (elliptical with broad front). The palate was of medium height, with a mild median bilateral torus. The teeth form a regular arch and are close in apposition, without either crowding or diastemae. The canines, in their roots and lower portion of the crown, were very much like and no larger than the anterior premolars. All the front teeth are stouter linguo-labially than they are in modern skulls. The glenoid fossa is of triangular shape, with the apex of the triangle directed forward and somewhat inward. It is decidedly smaller, especially in its transverse diameter, than it is in modern skulls, and its transverse plane is more inclined outward and upward.

There was evidently no styloid. Between what represents the base of the styloid and the retrotympanic ridge passing from the spinous process towards the posterior part of the border of the external meatus and the mastoid, there is a rather broad and marked depression, which is not found in modern skulls. The mastoid was plainly situated less outwardly than in modern crania. The digastric groove is short and broad; it is in reality a fossa rather than a groove. The petrous portions of the temporal bone are on a level with the surrounding parts of the face, as in the anthropoids and some of the most primitive of human skulls.

Endocranially, the skull shows a number of interesting features. There is, throughout, a marked paucity of impressions of brain convolutions, and also of those of the blood vessels. Even the sinuses have left but shallow grooves. The brain itself was not particularly small for a female skull; and it was already of a rather advanced human type. The anterior parts of the frontal bone are rough. The roofs of the orbits are somewhat more elevated, especially mesially, than in modern skulls, encroaching thus on the frontal lobes. The olfactory or mid-frontal fossa is deeper and more spacious than that in recent crania, and is of different form. The frontal lobes were relatively large but low, especially anteriorly; the middle or temporal fossa was relatively small; and the same is true of the cerebellar fossae, which were smaller from side to side as well as sagitally, and more shallow, than is usual in modern skulls. The pituitary fossa, damaged, was evidently near the average size of the structure in modern crania. The petrous bones, especially in their mesial parts, are stouter than they are in female skulls of modern times.

There are other details and dimensions about the specimen which are of more or less interest to the anthropologist, but which need not be dealt with in this paper. It will suffice to say that both the visual and the instrumental examination of the specimen lead to the conclusion that the Gibraltar skull represents a highly valuable relic of an early human being and that its principal characteristics justify its classification with the *Homo neanderthalensis.*

THE GIBRALTAR SKULL

Measurements on the Original

	Broca	Sollas	Sera	Keith	Hrdlička
Vault:	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Length max.					
(glabella-occip.)	....	19.0	....	....	19.3
(glabella-inion)	....	18.8	18.8	....	....
(ophryon-inion)	....	18.1	....	....	....
Breadth max., estimated	....	14.4	....	....	near 14.8[1]
Cranial index	....	close to *80.0*[2]	....	....	close to *77.0*
Height, basion-vertex (estimated)	....	11.7–12.2	....	....	....
Basion-bregma	....	....	....	....	near 12.2
Height-breadth index	....	....	....	....	near *82.5*
Mean height index	....	....	....	....	near *71.5*
Calottal height (glabella-inion line to vertex)	....	8.2–8.7	....	....	....
Diam. frontal min.	....	....	....	....	near 9.9
Thickness min. of frontal bone near bregma	....	7 mm.	....	....	....
at ophryon	....	14 mm.	....	....	....
Cranial capacity, estimated.	....	1260 cc. 1250 cc.	....	1200	....
Face height (alveolar point-nasion)	....	near 8.2	near 8.2	....	near 8.0
Interorbital breadth, min.	2.3	....	....	....	....
Orbits: Breadth (mesial landmark?)[3] r.	....	4.3	4.4	....	....
l.	4.4	4.3	4.4	....	....
from dacryon r.	....	....	....	....	close to 4.0
l.	....	....	....	....	4.0
Height r.	3.9	(3.9)[4]	(3.9)[4]	....	4.0
l.	3.9	(4.0)	(4.1)	....	3.8
Depth r.	5.1	....	5.3	....	....
l.	....	....	....	....	....
Orbital index (mean)	....	....	....	....	*97.5*
Nose:					
Height of aperture	....	3.45	3.6	....	....
Height (probably to base of spine)	....	....	5.7	....	....
Height, nasion to lowest points on borders of notches, mean	....	....	....	....	5.85
Aperture, breadth max.	....	3.3	3.4	....	3.4
Nasal index	....	....	....	....	*58.1*

THE GIBRALTAR SKULL

Measurements on the Original—Continued

	Broca	Sollas	Sera	Keith	Hrdlička
Upper alveolar arch:	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Median length to line of rearmost points of 3rd molars	5·4	....	....	....	....
to posterior limits of arch	....	near 6.7	....	....	near 6.7
Breadth max., external	7·1	7·0	....	....	7·0
Index	....	*95·7*	....	....	*95·7*
Thickness of right parietal, along a line 1 cm. above squamous suture	....	....	....	....	6–9 mm.

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[1] Taken on the reconstructed skull (original); the reconstruction is so good that there can be but little error; though it is possible that the original may have been a trace narrower.

[2] Evidently an error; his figures (p. 322) give *75.8*.

[3] These measurements could not have been taken from the standard landmark of dacryon; they doubtless are measurements of the contour of the orbits.

[4] These are reversed and one author had apparently copied the other; the right orbit is the higher.

ENDOCRANIAL MEASUREMENTS

		cm.
Whole Cavity:	Greatest length of brain (left hemisphere)	16.4
	Maximum length, right side, measured	16.2
	Maximum breadth, estimated	12.8
	Cerebral index, close to	*79·0*
	Anterior or frontal fossa (all fossae right side): Length[1]	5·2
	Middle or temporal fossa	5·0
	Postero-superior or occipital cerebral fossa	7·6
	Postero-inferior or cerebellar fossa	5·7

Comparisons

(Right Side)	11 Mesocephalic U. S. Whites Male	6 Mesocephalic U. S. Whites Female	Gibraltar Skull	Anthropoid Apes (Chimpanzees, Orangs and Gibbons)
Anterior fossa: Length	5·22	5·05	5·20	....
Percental relation to max. endocranial length	*29·5*	*30·4*	*32·1*	*34·4–37·5*
Percental relation to total length of fossae	*27·9*	*28·2*	*29·2*	....
Middle fossa: Length	5·53	5·27	5·0	....
Percental relation to max. endocranial length	*32·2*	*33·0*	*30·9*	*33·2–35·3*
Percental relation to total length of fossae	*29·5*	*29·4*	*28·2*	....
Posterior cerebral fossa: Length	7·96	7·58	7·60	....
Percental relation to max. endocranial length	*46·0*	*46·8*	*46·9*	*42·5–48·5*
Percental relation to total length of fossae	*42·6*	*42·4*	*42·7*	....
Cerebellar fossa: Length	6.26	6.16	5·7	....

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[1] For methods and comparative data see Hrdlička, A. Measurements of the Cranial Fossae. Proc. U. S. Nat. Mus., Vol. 32, pp. 177–232, 1907.

ADDITIONAL EXPLORATIONS AND FINDS AT GIBRALTAR

Between 1863 and 1866 Professor G. Busk explored a number of caves at and in the vicinity of Gibraltar. In these he collected several skulls and a series of bones, all of which, however, belonged to the Neolithic age. Busk reported on his work before the Prehistoric Congress of Norwich in 1868; and a report on the bones and skulls, together with the measurements of the latter, is given by Paul Broca (Bull. Soc. Anthrop., Paris, 1869, Vol. 4, pp. 145-158).

In 1910 and again in 1911, W. L. H. Duckworth, of the Cambridge University, visited Gibraltar for the purpose of obtaining, if possible, additional information about the old skulls, and of making further exploration. The results are published in two reports.[1] He found that Forbes' Quarry still existed, though, having been worked at intervals since 1848, its boundaries were larger. The quarry, as originally noted, is under the north front of the Rock of Gibraltar. The rock at this point contained still a remnant of a cave, which was not more than about 30 feet above sea level and "was probably the result of marine erosion at a remote epoch; and at a remote epoch also, the mouth of this cave must have been closed, until it was reopened by the quarrymen." It was in all probability this cave in which the skull was discovered. A partial exploration of the cave and the neighboring talus was barren so far as remains of man were concerned. A second cave in the rock, explored by Dr. Duckworth, gave remains of the Neolithic period.

In the latter part of 1910, a stone-slide obstructed both the quarry and the cave, making the latter accessible only with great difficulty. The work of 1911 added but little of importance to that of 1910. But one of the caverns (Sewell's Cave) yielded, with others, some Mousterian, Aurignacian, Solutrean, and even Magdalenian, stone implements.

EXPLORATIONS BY ABBÉ BREUIL

In 1917 parts of the Rock of Gibraltar and the neighborhood were investigated by Abbé Breuil. During this work the Abbé discovered near the "Devil's Tower" a rough rock shelter which gave indications of paleolithic man. This site, in 1926, was explored in detail by Miss D. A. E. Garrod; and it was here that in June, 1926, Miss Garrod found, enclosed in rock, the skull of a child, proceeding evidently from the Mousterian period. This skull will be described later.

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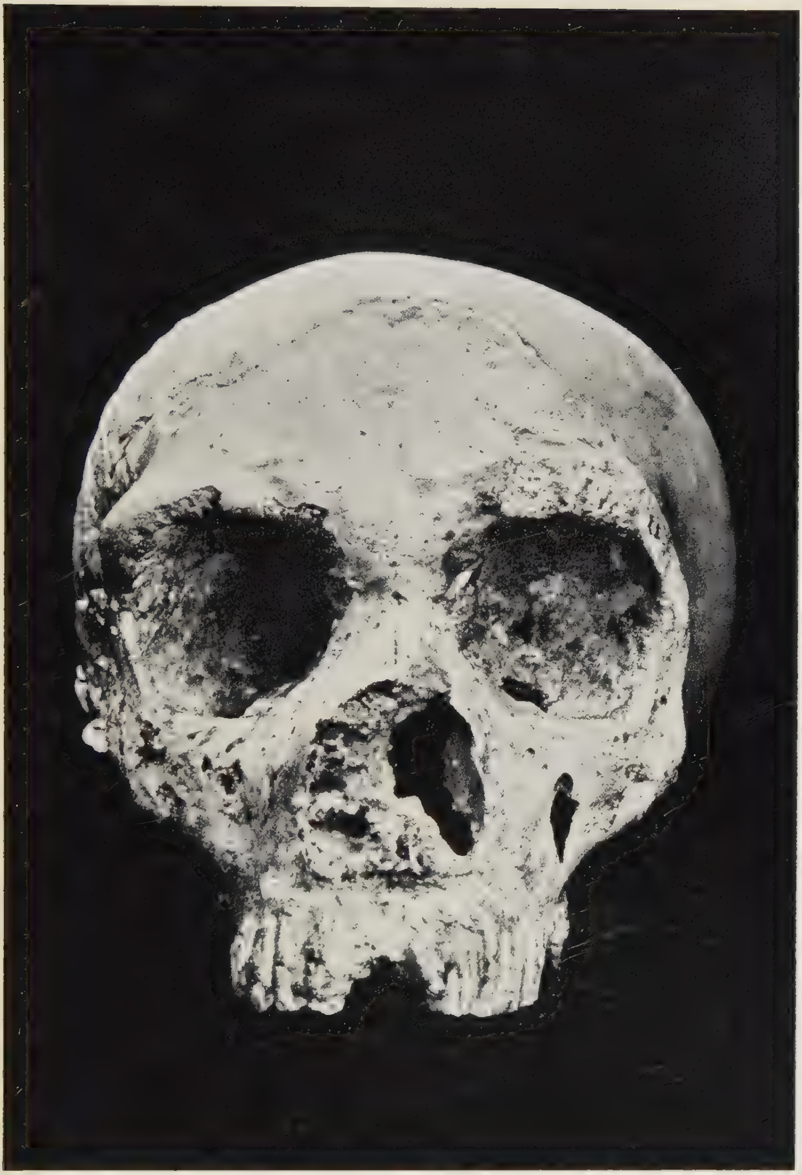
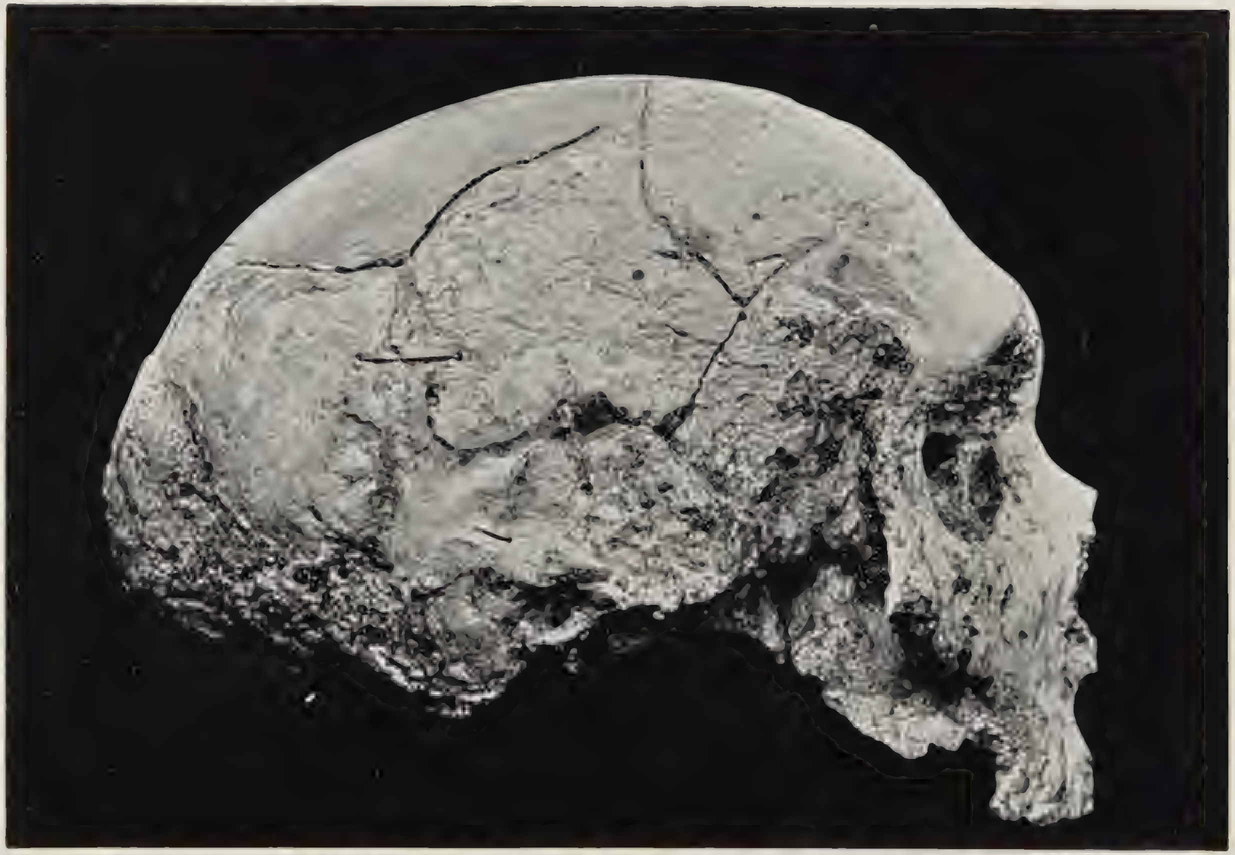
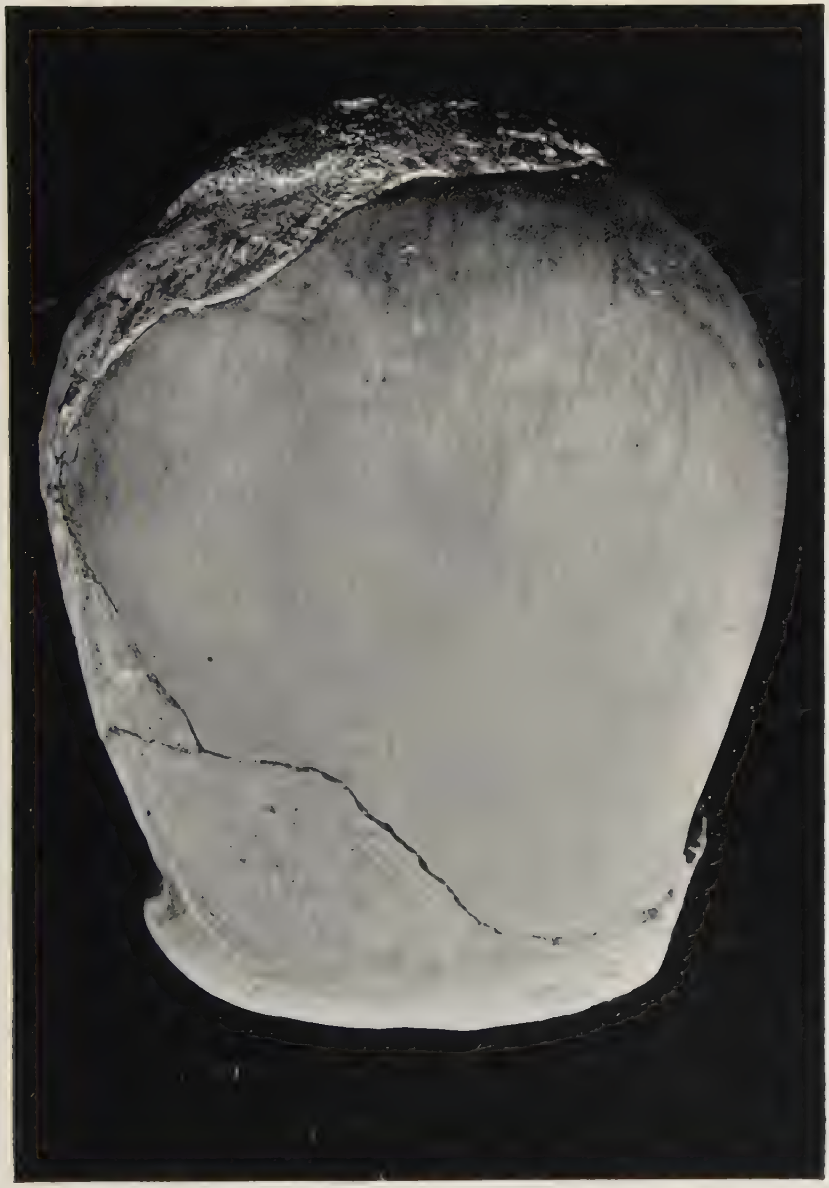
[1] Duckworth, W. L. H., Cave Exploration at Gibraltar in September, 1910. Journ. Roy. Anthrop. Inst., Vol. 41, pp. 350-380, London, 1911; Cave Exploration at Gibraltar in 1911. *Ibid.*, Vol. 42, pp. 515-528, 1912.



The Gibraltar skull (1848). (Photograph from Royal College of Surgeons, London.)



The Gibraltar skull (1848), side view. (Photograph from the Royal College of Surgeons, London.)



The Gibraltar skull (1848), top view. (Photograph from the Royal College of Surgeons, London.)

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The skull is dealt with also in all the general treatises on Prehistory.

THE CHILD SKULL OF GIBRALTAR

For the discovery of this interesting specimen, science is indebted to Miss Dorothy Garrod, English prehistorian. The specimen was found in June, 1926, embedded in hard rock in some Mousterian deposits fronting a small cave opposite the ruin of "Devil's Tower," in the eastern face of the north front (Spain front) of the Rock of Gibraltar, not very far from the Forbes Quarry, in which in 1848 was discovered the adult Neanderthaloid skull of Gibraltar. The find and the specimens recovered were described by Miss Garrod, Professors Buxton and Elliot Smith, and Miss Bate, before the Royal Anthropological Institute, November, 1927, and the several reports were published in the Journal of the Institute.[1] The details of the find are given by Miss Garrod; the main points are as follows:

> The Mousterian site at Devil's Tower was discovered in 1917 by the Abbé Breuil, then acting as diplomatic courier between Gibraltar and the French Naval Bureau at Madrid (1). In the course of a visit to the North Front of the Rock he noticed fragments of fossil-bone in the talus of a small cave or rock-shelter at the foot of the immense vertical peak of Rock-Gun, immediately opposite a ruin known as the Devil's Tower. M. Breuil was unable to follow up this discovery at the time, but in 1919 he returned to Gibraltar and with the help of the late Colonel Willoughby Verner dug a trial trench a little way down the talus of the shelter, unearthing a number of animal bones and four stone implements of

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[1] Garrod, D. A. E., with L. H. D. Buxton, G. Elliot Smith, and D. M. A. Bate, Excavation of a Mousterian Rock-Shelter at Devil's Tower, Gibraltar. Journ. Roy. Anthrop. Inst., Vol. 58, pp. 19-113, 7 pls., 25 figs., 1928.

definite Mousterian type. My own work on the shelter, undertaken at M. Breuil's suggestion, occupied seven months, between November, 1925, and January, 1927, and was carried out by means of a grant from the Percy Sladen Memorial Fund.

The Devil's Tower cave is a narrow fissure running obliquely into the Rock of Gibraltar at the eastern end of the North Front, 350 m. from Forbes' Quarry. It has a maximum height of 12 m. and a maximum width of 1.20 m., and 4 m. from the entrance it narrows to a mere crack. The rocky floor at the cave mouth lies 9 m. above sea-level, and 5 m. above the average level.

The work carried out consisted in emptying the cave down to the rock floor and removing the talus or terrace deposits over an area extending from the rock wall which bounded them on the west to a line 4.50 m. to the east of the cave mouth. Seven layers of deposit were revealed in this way, the succession from above downwards being as follows:

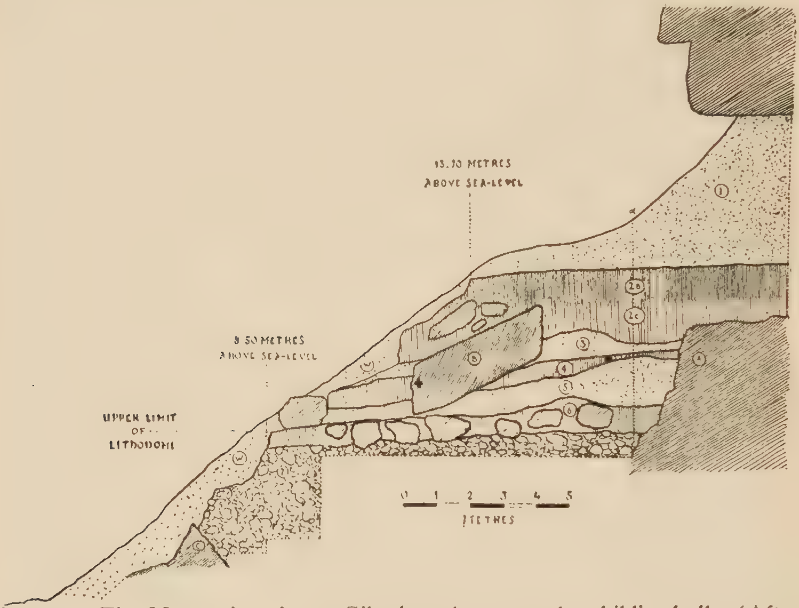

FIG. 17.—The Mousterian site at Gibraltar that gave the child's skull. (After Miss Garrod.)

1. Fine sand. 2. Calcareous tufa. 3. Fine sand. 4. Brownish-grey travertine or tufa. 5. Fine sand. 6. Pink travertine. 7. Raised beach. *W*. "Wash" of sandy rubble. *A*. Rocks blocking the fissure. *B*. Fallen rock. *C*. Rampart of rock in front of raised beach. + + Portions of human skull.

1. Fine sand, filling the fissure to the roof.
2. Calcareous tufa, 1-4 m.
3. Fine sand, 20 cm.-1 m.
4. Travertine, 10-80 cm.
5. Fine sand, 40 cm.-1.40 m.
6. Travertine, 50-75 cm.
7. Raised beach, with its surface at 8.50-9 m. above sea-level.

Layers 1-5 contained archaeological material, the industry from top to bottom being Mousterian.

The total number of implements and flakes recovered was small—less than 500, the majority in quartzite, the rest in flint, chert, and jasper. There were also two fragments of bone compressors.

> The industry of layers 1 and 2, and the implements found in the "wash" have a well-marked Upper Mousterian character. Specially typical are the utilized bones, the curved points of Audi type, the narrow well-made straight points, the preponderance of scrapers, and the high proportion of flakes so slender that they may fairly be described as blades. The industry of the lower levels is so poor as to be in no way typical, but the presence of a graver in layer 4, taken together with the general uniformity of technique throughout the site, and the absence of more archaic forms in the "wash," suggests that these, too, belong to the Upper Mousterian.

The fauna, too, as determined by Miss Bate, was much the same at all levels. The mammals, found in the various layers (except the seal and the elephant which occurred in the raised beach), included the following:

Talpa europea
Crocidura russula
Myotis, cf. *myotis*
Nyctinomus teniotis
Canis lupus
Ursus arctos
Meles meles
Hyaena crocuta
Felis pardus
Felis, cf. *sylvestris*
Lynx pardellus
Monachus albiventer
Oryctolagus cuniculus
Eliomys quercinus
Apodemus sylvaticus
Arvicola sp.
Pitymys sp.
Microtus brecciensis
Hystrix cristata
Sus scrofa
Cervus elaphus
Bos, cf. *primigenius*
Capra pyrenaica
Equus sp.
Elephas sp.

There were also the remains of numerous birds, a tortoise, a few fish, and many shells of both marine and land molluscs.

The human skull was found in the travertine of layer 4, under the following conditions, according to Miss Garrod:

> Towards the end of May, 1926, I was obliged to put a heavy charge of blasting gelatine into the rock (B) which blocked the terrace in front of the cave. This rock ran obliquely downward from the middle of layer 2 to the base of layer 4, and when it was blown up the explosion opened a large number of cracks in the surrounding travertine. Into these cracks wedges were inserted, and the travertine, which at this point was very hard, was removed in great blocks which were afterwards broken up with a hammer. On June 11th a big lump was removed slightly to the west of the gap left by rock (B), and 5.50 m. from the cave-mouth. On examining the face of the travertine left in place I noticed a thin edge of bone in the section, about 10 cm. from the surface of the layer. The surrounding deposit was very much cracked, and, after prizing open the cracks with a tool, I was eventually able to remove with my hands a chunk of travertine to the under surface of which adhered the bone of which I had seen the edge.

This proved to be the frontal of a human skull, the outer surface of which had become completely detached from the surrounding deposit, while the inside remained filled with travertine. Three-quarters of an hour later the removal of another large block exposed a broken edge of a human parietal lying about 1 m. to the east of the frontal and at the same depth from the surface. The crack in the travertine had passed right through the bone, breaking up the edge which bore the sagittal suture, but I was able to recover the fragments. The part which remained *in situ* was completely embedded in the matrix, and it was necessary to chip away a block large enough to contain the whole bone.

The deposit surrounding the skull was carefully searched, but without result, and at the end of a week I was obliged to close down the dig on account of the heat. I returned to Gibraltar early in October, and three weeks later found a human lower jaw, right maxilla, and right temporal in layer 4, all lying close together in the mouth of the cave, 5.50 m. from the place where the frontal and parietal had been found. The jaw and temporal were in the crumbling tufa already described as filling the fissure at this level, but the maxilla, although only a few centimeters away, was embedded in a bank of hard travertine which lined the eastern wall.

Although layer 4 was afterwards searched over its whole extent, no other human bones were found.

It seems clear from the position of the bones that the skull originally lay in the mouth of the cave, but as it belonged to a very young individual it fell apart along the sutures, and the frontal and left parietal, together with those parts which are missing, were washed forward on to the terrace by the waters of the spring which converted the original sandy layer into travertine. The missing parts were probably carried further forward than the others, and so rolled down the slope and were lost.

It is probable that the skull was already separated from the body when it lay in the cave, for if the whole skeleton had been present some, at least, of the bones must have been found. On the other hand, the fact that the lower jaw lay quite close to the temporal and maxilla suggests either that decomposition was not complete at the time of deposition or that the jaw was fastened to the skull by a thong or string. In either case it seems impossible to avoid the conclusion that the skull was intentionally preserved, either as a trophy or in fulfilment of a pious rite.

THE SKULL

The human skull is described most carefully and with much detail by Professor Buxton. The main results of his study are:

> The Devil's Tower bones are the remains of a single individual skull belonging to a child of five years old, probably of the male sex. . . . . The form of the face and jaws is essentially that which we associate with Neanderthal man. Many of these features can be shown, however, to owe their characteristic appearance partly to the great size of the teeth and partly to functional activities, but the general massiveness, not only of the jaws but also of such features as the tympanic plate, is remarkable.
>
> . . . . the contours of the forehead are, when seen from the side, almost exactly similar to contours of the La Quina child, but the size of the specimen is

very unusual. . . . . The dimensions and form of the brain-case, especially the expansion of the frontal area, are beyond the range of Neanderthal man, as hitherto discovered, if we make the same allowance for age that we should do in the case of a modern child. These conditions suggest a brain-case built more after the fashion of modern than of Neanderthal man. . . . . The teeth of our specimen closely resemble in size and shape those usually associated with Neanderthal man. The face and jaws must therefore necessarily be close to the typical Neanderthal form. The brain-case is, however, different from the type form, because the underlying structure, the brain, was larger.

TABLE OF MEASUREMENTS

(By Buxton)

	cm.
Nasion to lambda	16.7
Glabella to lambda	16.9
Ophryon to lambda	16.4
Nasion-bregma arc	11.6
Nasion-bregma chord	10.2
Bregma-lambda arc	11.0
Bregma-lambda chord	10.1
Frontal width, min.	10.4 (?)
Frontal width, max.	12.5
Greatest breadth	15.0 (?)
Interfronto-malar width	9.25
Intraorbital width	2.45
Bicondylar width	10.2 (?)
Condylo-symphyseal length	8.1 (?)
Symphyseal height	2.1
Orbital width (from fronto-malar to fronto-nasal suture):	
Right	3.4
Left	3.5

Measurements of thickness of calvarium:	
(1) Along fractured edge of left parietal:	*mm.*
(a) At coronal suture	4.4
(b) At lambdoid suture	4.0
(c) 5 mm. post. to coronal suture (max. thickness)	4.9
(2) Elsewhere on parietal:	
(a) Opposite parietal eminences	4.9
(b) In center of parieto-squamous suture	5.1
(3) Thickness of frontal bone at bregma	5.0

THE BRAIN

The brain of the Gibraltar child, as shown by the endocranial cast, has been studied by Elliot Smith. His observations are of much interest. In all the other endocranial casts of Neanderthal man, he says,

> there is an obvious lack of fullness in the prefrontal, and less distinctly, superior parietal, areas of the brain. But in the endocranial cast of the skull from Devil's Tower these regions are fuller, and seem to present a marked contrast to the meagreness that strikes the eye in the case of all the other Neanderthaloid casts, in particular those of the Galilee and La Quina skulls. In fact the general contour of the cast suggests the possibility that the unusual fullness may be due to hydrocephalus; but the distinctness of the ridges corresponding to the convolutions and the depth of the intervening sulci render the pathological explanation improbable.

The point of chief interest about this brain is,

the high development of the prefrontal area. Although the prefrontal territory in the cast of the La Chapelle-aux-Saints skull appears to be both longer and higher than that of the Devil's Tower specimen, the latter differs from the former (and, in fact, from all the other Neanderthaloid specimens) in not exhibiting any depression (or obvious appearance of ill-development) in contrast to the precentral area of the cast. In other words, the front part of the brain of the Devil's Tower specimen presents at first sight a curiously modern appearance that sharply contrasts with the configuration of the other Neanderthal casts—and, in particular, with such examples as those obtained from the Galilee and La Quina skulls, in which the prefrontal area is so obviously diminutive and shrunken. . . . .

The brain of the infant from the Devil's Tower exhibits another feature of some interest. There is an exceptionally large gap between the inferior temporal convolution and the cerebellum on the right side (the only side from which the temporal bone was recovered). Moreover, the under-surface of the inferior temporal convolution is deeply hollowed and its margin bevelled. These facts suggest an exceptionally poor development of the temporal region comparable to the conditions revealed by the Piltdown and Rhodesian skulls.

Summing up the general conclusions to be drawn from the study of the endocranial cast, we may conclude that the child whose remains were found at the Devil's Tower was a normal representative of the Neanderthal species, with an exceptionally high development of the prefrontal region of the brain and a temporal area that was rather below the average size.

THE WRITER'S NOTES ON THE SKULL

The writer was so fortunate as to see the originals at their first presentation before the Royal Anthropological Institute, and again at Oxford; besides which he was favored through the courtesy of Professor Arthur Thomson with a set of good casts of the specimens.

The skull is represented by the whole frontal and the left parietal, a detached right temporal, most of the right maxilla, and the lower jaw. The skull impresses the observer by its relatively large size and large breadth, combined with relative lowness. The lower part of the frontal has a Neanderthaloid look. The interorbital process is very stout, much stouter than in any modern child of similar proportions; the glabellar region is broad, convex and considerably forward of what it is in present day skulls; and there is already a fairly distinct though still mild complete supraorbital torus with a shallow depression above it. The forehead is broad, of very uniform convexity from side to side, and as full and well arched as in modern skulls. The fronto-temporal fossa is more full than average at this stage of life in recent crania. There is no sagittal ridge, and the transverse arc is broadly oval.

The parietal shows a moderate and diffuse yet appreciable eminence midway on the bone from above downwards and but slightly posterior to the middle antero-posteriorly, and there was evidently no marked flattening of the parietals from the inion to obelion; all of which are recent rather than Neanderthaloid conditions.

The bones of the vault, including the separate temporal, are perceptibly stouter than in modern European skulls of similar age. The temporal bone, somewhat damaged, shows a very small mastoid; a cylindrical—not oval as at present—meatus; a stouter base of the zygoma than in modern skulls; a shallow, broad (transversely) glenoid fossa, slanting much upward and outward, and more strongly protected by bony walls along its whole posterior extent than is usual at present; a thick tympanic bone (though not more so than in some present children's skulls); and a bulky petrosa with a large internal meatus situated higher than is now usual. The upper borders of the orbits, especially on the left, are still fairly sharp, and in shape and otherwise much as at present, although larger and with the bones evidently thicker.

The nasion depression is in the form of a broad moderate concavity from above downwards. The nose was broader than in modern children. The sub-orbital region is full and distinctly convex, without any trace of the usual modern depression (canine fossa). The bones are relatively stout. The upper alveolar process is rather stout, and the teeth—the two right milk molars—are larger than in the modern child and relatively narrow. The median upper incisor, still completely enclosed but visible through damage to the anterior wall of its socket, is enormous, the crown measuring 11.5 mm. in maximum breadth by near 14 mm. in height. The still somewhat shallow palate is broad in front and is nearly **U**-shaped.

The lower jaw is about as stout in body as the stoutest jaws of that age today; in alveolar process, it is decidedly stouter than any modern mandibles. Relative to the size of the skull it appears small, but compares well in size with modern jaws of similar dental age (length, posterior border of ramus to symphysis, along the middle, close to 7.8, bigonial breadth near 7.4 cm.).[1] The symphyseal region is broad, but slightly convex from side to side, with already a fairly distinct dull angle at the canines, and slightly receding from the vertical. It is a typical Neanderthaloid jaw. There is but a faint suggestion of chin eminence.

The height at symphysis and along the body is moderate (at symphysis, 2.1; at M1, 1.85 cm.), compared with that of various modern mandibles of similar age. The thickness of the body (at symphysis, 1.3; at M1, 1.4 cm.), is considerable, but not in excess of Indian, Eskimo, and other similar mandibles of the present time.

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[1] All the measurements here given were taken on the cast of the specimen.

Lingually, there is visible anteriorly a rather marked alveolar plane or upper simian shelf, which is nevertheless approached in degree in some modern child mandibles, and a distinct, complete, fairly sharp median ridge ("transverse torus" of Holl) bounds the plane beneath and extends on each side backward, where it blends imperceptibly with the mylohyoid ridge. There are no depressions as yet above this ridge, with undifferentiated conditions below. The inferior border, evenly arched, presents already a fairly marked, broad, Neanderthaloid digastric flattening, but posterior to the milk molars the border is as in stouter modern jaws.

The ramus is stouter than in modern mandibles, more slanting (mandibular angle 125°), fairly though not excessively broad (breadth min. 2.8), and somewhat low (height from middle of line connecting the condyle and the coronoid to middle of lower border, 3.8 cm.). The notch is shallow. The coronoid process is stout but short; the condyle is still of moderate thickness and narrow (diam. antero-post., 7; transverse, 1.4 cm.). The outer surface of the ramus is rather full and smooth, the inner as in strong jaws of similar age today. The angle is as in modern bones.

THE SPY SKELETONS

In the district of Spy, province of Namur, Belgium, on a steep, wooded mountain side, the base of which is skirted by the small stream of Orneau, there is a great protruding rock, and in its base a moderate sized cave now known as the cave of Spy. The rock, due to its form, is known locally as the "Bec (or Bèche) aux-Roches." The cave, which is about 60 feet above the level of the stream, opens toward the south, a feature which together with the fair inside dimensions and good outlook of the cave made it a favorable site for early human habitation. Traces of such habitation were found long before the eighties of the last century, and as interest in human prehistory grew, the accumulations within were dug over more or less thoroughly a number of times, notably by M. Rucquoy,[1] yielding remains of upper Quaternary fauna, late paleolithic worked stones, and worked bones, some of which showed graved lines. On the

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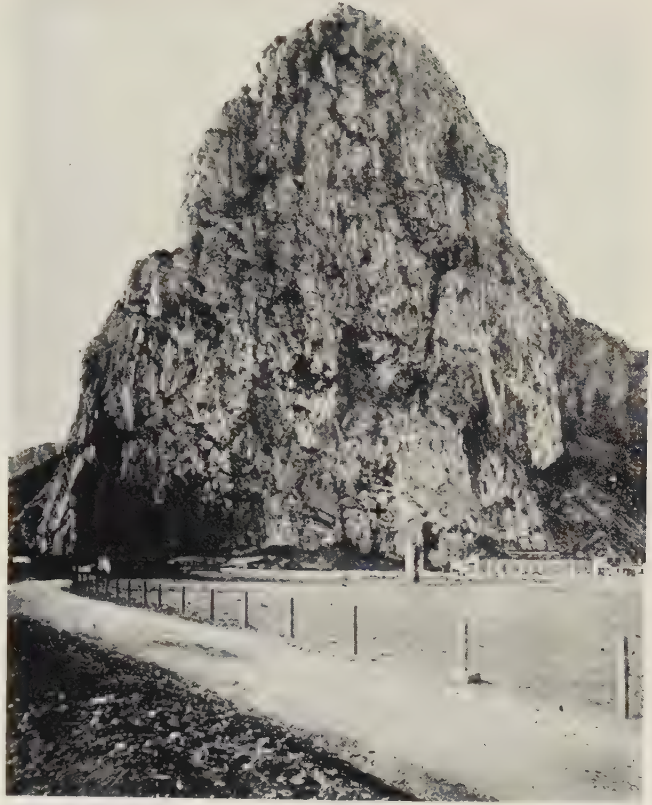
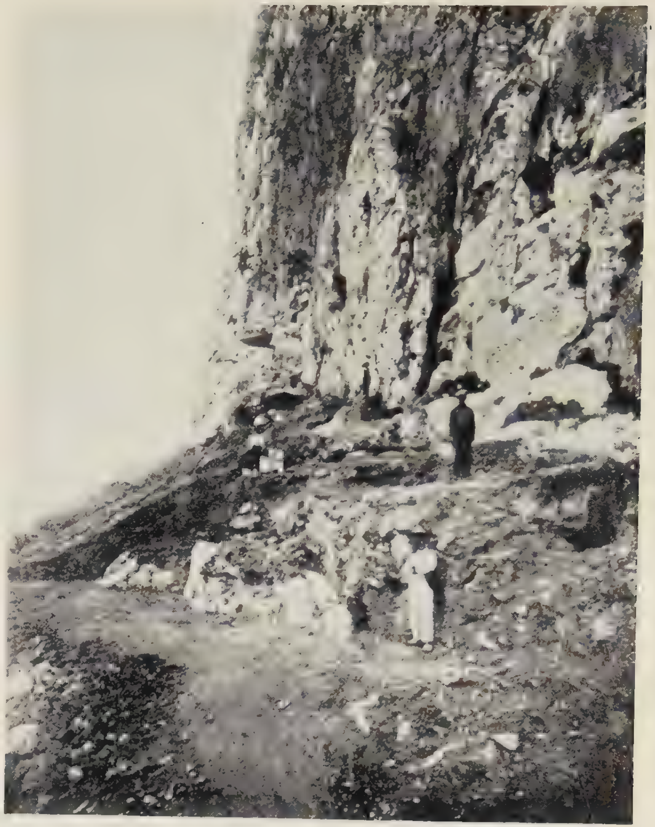
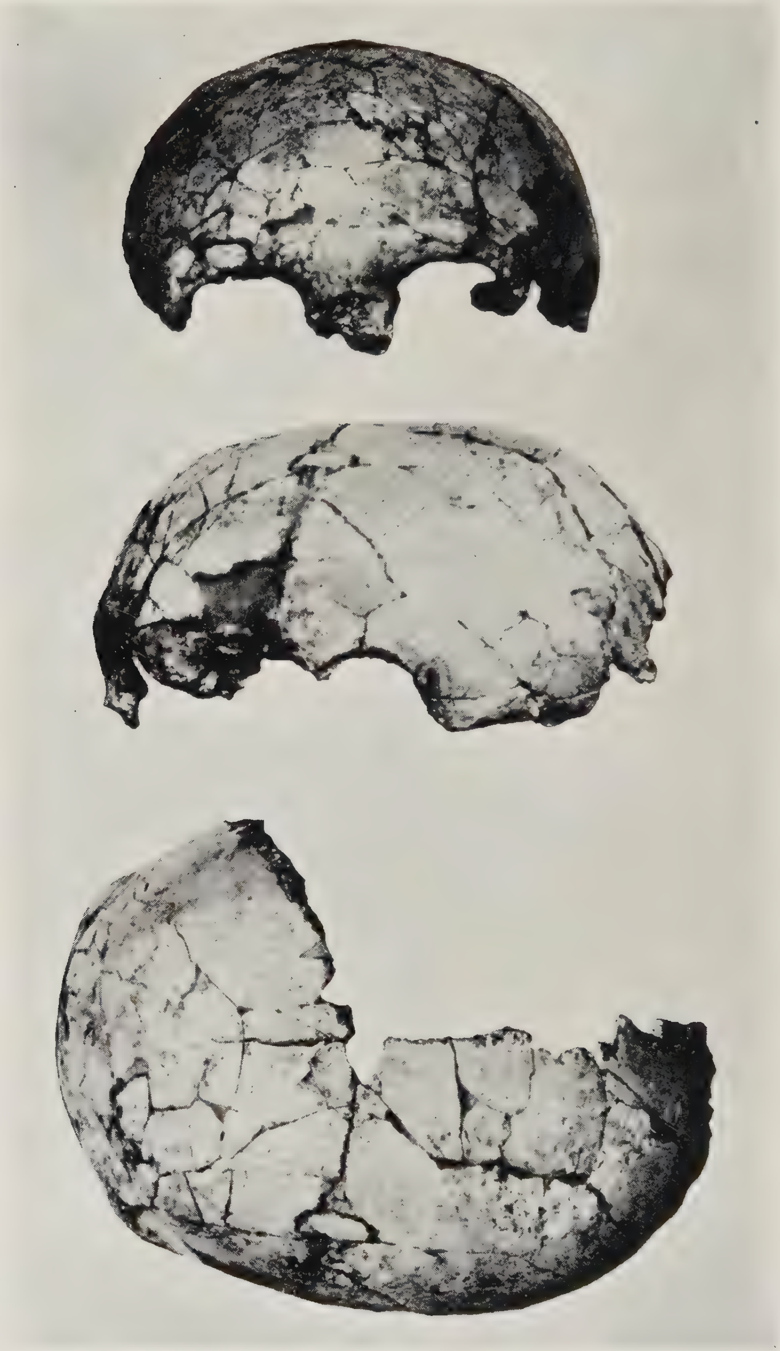
[1] Rucquoy, M., Notes sur les fouilles faites en aout 1879 dans la caverne de la Bèche-aux-Roches, près de Spy. Bull. Soc. Anthrop., Vol. 5, pp. 318-328, 2 pls., Brux., 1886-7.



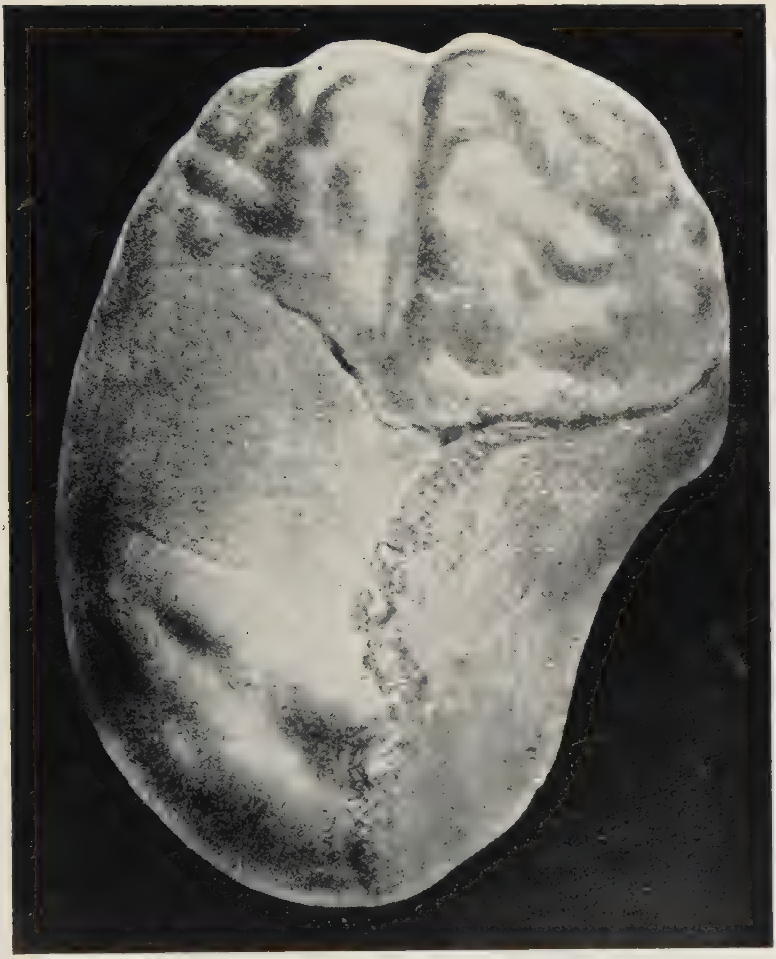
1. View of rock-gun from the eastern beach, Gibraltar, showing the Devil's Tower cave (marked with a black cross). (After Garrod, Journ. Roy. Anthrop. Soc., 1928.)



2. View of the Devil's Tower site after the "wash" of sandy rubble had been removed. The man in white is standing against the raised beach; the others are on the edges of the different layers of tufa and travertine. (After Garrod, Journ. Roy. Anthrop. Soc., 1928.)



The Gibraltar child's skull. (After Garrod and Buxton, 1928.)



The endocranial cast of the neanderthaloid child's skull of Gibraltar.
(After Elliot Smith, 1928.)

plateau above the hillside were found also a large number of worked flints, partly like those of the cave, partly more recent to neolithic.

In 1885 a more systematic and extensive exploration of the cave was begun by Marcel de Puydt, Member of the Archeological Institute of Liége, and Maximin Lohest, at that time Assistant in Geology at the University of Liége. These explorers found the cave much worked over, but a large, high terrace in front of the cave had evidently not as yet been touched, and upon this terrace they concentrated their attention. A trench sunk in the terrace to a depth of four feet revealed a thick layer of brown earth with numerous fragments and blocks of limestone fallen from the rocks above, beneath which the explorers found an ossiferous layer 30 to 40 cm. (12 to 16 ins.) in thickness, containing also numerous flint implements. From the deposits above this layer, apparently, the explorers recovered some worked flints and bones, some débris of pottery, and a fragment of a human skull, which made it appear that the lower ossiferous layer was not the sole layer here of human habitation.[1]

The total number of worked flints recovered during the 1885 excavations reached several thousand.[2] In addition there were recovered numerous points and awls of bone, three polished fragments of ivory covered with graved lines, one oval ivory bead, a flat bone with several series of parallel or crossed lines, two other decorated bones, and a perforated tooth of a young hyena, evidently used as a pendant. The stone implements, of relatively high-class workmanship, ranged themselves with the Mousterian.

The explorations by Messrs. De Puydt and Lohest were resumed in 1886, and in June of that year the excavators discovered in the terrace the remains of two remarkable human skeletons, besides large quantities of bones of Quaternary animals and flints and other industrial objects, a large proportion of which showed Mousterian affinities. The discovery was brought to the attention of Professor J. Fraipont of the Liége University; and on August 16, 1886, De Puydt and Lohest announced the important find to the Congrès archéologique of Namur.[1] Later the same year Fraipont and Lohest published an account of the discovery, with the first description of the skeletal human remains, in the Bulletins of the Royal Academy of Belgium.[2]

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[1] De Puydt, Marcel, et Lohest, Max. Exploration de la grotte de Spy. Ann. Soc. géol. Belg. Liége, Vol. 13, pp. 34-39, 1886; also, L'homme contemporain du mammouth à Spy, province de Namur (Belgique), with 10 pls. Bruxelles, 1887.

[2] "Des silex et ossements, quelques débris de poterie et un fragment de crâne humain, trouvés dans les terres lors du creusement, font, il est vrai, supposer qu'il pourrait y avoir d'autres niveaux ossifères plus ou moins caractérisés" (p. 35).

According to this last-mentioned account, the terrace extended for about 11 meters (36 feet) in front of the cave. The human bones were found at a depth of 13 feet from the surface, which here rose considerably higher than the threshold of the cave. The accumulations that formed the terrace included rocks, fallen calcareous blocks and débris, earth, many archeological traces of man's presence, and numerous remains of fossil animals. They could be separated into several strata, none of which showed any perceptible disturbance.

Skeleton No. 2 lay 6 m. (nearly 20 ft.) to the south of the entrance of the cave; skeleton No. 1 was 2.50 m. (8.2 ft.) further in the same direction. Skeleton No. 1 lay transversely to the axis of the cave, with head to the east and feet to the west. It lay on the side with one hand applied to the lower jaw. The bones were enclosed in an undisturbed layer of argilaceous tufa, from which they could be liberated only with much difficulty and damage.

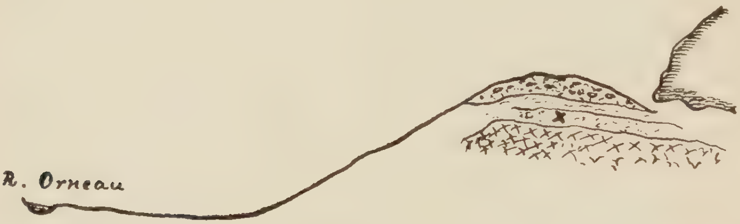

FIG. 18.—The terrace in front of the Spy Cave. (After Fraipont and Lohest.)

More in detail, a section of the deposits showed them to consist of:

A. Brown earth and fallen rocks; thickness approximately 2.90 m. (over 9 ft.). No paleontological or human remains.

B. Yellow argilaceous tufa, enclosing limestone blocks, 0.80 m. (2½ ft.) in thickness. This layer could be broken only with difficulty by the pick. It gave some bones of the mammoth and deer, and also some worked flints.

C. A stratum 15 cm. (6 ins.) thick, strongly colored red, and containing many flint implements, rejects of stone industry, angular fragments of limestone, bits of charcoal, and débris of mammoth tusks. This layer formed a hard crust, resistant to the hammer, and covered the human skeletons.

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[1] De Puydt, M., and Lohest, M., L'homme contemporain du Mammouth à Spy. C. R. Congr. de Namur, 1886. Also in a separate pamphlet.

[2] Fraipont, J., and Lohest, M., La race humaine de Neanderthal ou de Canstadt en Belgique. Bull. Acad. Roy. Belgique, Vol. 12, pp. 741-784, 1886.

The animal remains found in the hard layer, C, that overlaid the two human skeletons were:

Rhinoceros tichorinus
Equus caballus
Sus scrofa
Cervus elaphus
Cervus canadensis?
Cervus megaceros
Cervus tarandus
Ovis aries?
Bos primigenius
Bos priscus
Elephas primigenius
Lepus sp.
Ursus spelaeus
Meles taxus
Mustela foina
Canis vulpes
Canis lupus? (familiaris?)
Hyaena spelaea
Felis spelaea
Felis catus

D. Yellow calcareous clay and rubbish (comp. p. 692 Fraipont and Lohest report), passing to a tufa of the same nature as that in layer B. Thickness 15 cm. (6 ins.) uneven; at base a streak of charcoal.

E. The human skeletons and worked flints.

F. Brown clay, in places black, enclosing angular pebbles of limestone, numerous animal bones and worked flints.

The animal remains encountered at the level of the skeletons or lower than these, comprised the following:

Rhinoceros tichorinus (abundant)
Equus caballus (very abundant)
Cervus claphus (rare)
Cervus tarandus (very rare)
Bos primigenius (fairly abundant)
Elephas primigenius (common)
Ursus spelaeus (rare)
Meles taxus (rare)
Hyaena spelaea (abundant)

Aside from the surface material, three distinct fossil bearing layers were therefore distinguishable, namely:

B. This contained bones of the mammoth and deer; also some Mousterian-like flint implements of refined and rather peculiar type.

C. This stratum, with the underlying few inches of earth, covered the human skeletons. Contents: Bones of many Quaternary animals; abundance of flint blades, Mousterian points, and other flint implements, in general of less refined make than those of layer B; also implements of bone and ivory. Among the bones were needles, awls, beads, and pendants, and a number of the bones were decorated with linear designs. Some of the bone pendants had evidently once been colored red.

D. to F. The stratum of the two human skeletons. Gave also some bones of Quaternary animals, and some stone implements of Mousterian type but inferior in workmanship to those from the layers above. The human remains, the authors thought, were not burials but accidental inclusions. And as the middle hardened stratum was found undisturbed, the skeletons could not have been more recent than this stratum.

In view of the importance of the original report concerning layer C, the relevant parts are given here in the original:[1]

Deuxième niveau ossifère. Le niveau immédiatement supérieur à celui des squelettes a procuré en abondance des lames, des pointes moustiériennes en silex et en phtanite et en outre, un instrument très commun, très épais ayant la forme d'un losange, constituant un type intermédiaire entre le grattoir et la pointe moustiérienne.

Les lames, tant en silex qu'en phtanite, sont relativement courtes et larges. Des poinçons, perçoirs, burins et aiguilles en silex apparaissent à ce niveau. L'abondance des instruments en os et en ivoire y est caractéristique. La couche de déchets provenant de l'ivoire taillé atteignait par place 15 centimètres d'épaisseur. Parmi les divers instruments d'os et d'ivoire on distingue des bâtons ronds ou ovales, des poinçons, des perçoirs, des aiguilles, des perles et des pendeloques. Quelques os creux sont ornés de dessins linéaires, et certaines pendeloques, d'une forme originale, ont probablement été teintes en rouge par de l'oligiste, répandu du reste à profusion dans tout le niveau. Quelques fragments de poterie se joignent [? see first account, also last paragraph of these quotations] à la trouvaille, mais ni harpon, ni bâton de commandement n'ont été recueillis; enfin sur les différents objets en ivoire ou en os on n'a observé aucune tentative de reproduction de figures d'animaux au moyen de la gravure.

Certaines roches utilisées pour la confection des instruments situés à ce niveau ne se rencontrent pas en Belgique; telles sont l'opale xyloide et l'agate. . . . .

L'inspection de la coupe p. 663 indique clairement que l'on ne peut considérer les squelettes de Spy comme étant d'âge plus récent que celui du dépôt des couches C et F.

La zone C constituée par une brèche dure, colorée en rouge, recouvrait les squelettes [elsewhere mentions a few inches of earth—see next page], et si cette brèche eût été percée à une époque postérieure à sa formation, on s'en serait immédiatement aperçu lors des fouilles. Nous avons au contraire constaté qu'elle était intacte.

On pourrait cependant prétendre que les hommes qui ont laissé de nombreuses traces de leur existence dans la zone C, aient, lors de leur prise en possession de la grotte, enterré deux des leurs dans celle-ci, et continué ensuite de l'habiter en accumulant au-dessus de ces cadavres leurs débris de cuisine et les rebuts de leur industrie. S'il en était ainsi, les hommes de Spy seraient encore contemporains du mammouth, de l'ours des cavernes et du rhinocéros, mais auraient eu une civilisation relativement avancée, puisqu'ils auraient enterré leurs morts, connu la taille de l'os et de l'ivoire, l'usage de poterie, des ornements et de la couleur.

A further remark as to the pottery is found on p. 679:

Les morceaux de poterie n'ont pas été recueillis à Spy par les explorateurs, mais ils ont tout lieu de les croire authentiques et de ne pas douter qu'ils proviennent bien du second niveau.

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[1] From Fraipont and Lohest, La race humaine de Neanderthal ou de Canstadt en Belgique, pp. 587-757, 1887.

As to the age of the Spy skeletons, Fraipont and Lohest tell us that they regard them as belonging to the time of the third or lowest layer of the terrace. The second or middle fossil-bearing layer (C) belonged to a different industry which so far (p. 692), "has no equivalent either in or outside of Belgium. It belongs, through its numerous worked bones and ivory, to Mortillet's Magdalenian, and through its flints to the Mousterian." Between the skeletons and layer C, however, there was but little accumulation—from a thin covering over one of the skulls to 15 cm. (6 ins.) in thickness, mainly rubbish ("eboulis"). This would seem to indicate no great interval between the death of the Spy men and the coming of the inhabitants of the middle layer (C), with an industry that differed so much from, yet also retained some resemblances to, that of their predecessors; but here much is uncertain.

From 1906 to 1909, further explorations in the cave of Spy and its terrace were carried on under the auspices of the Musée du Cinquantenaire in Brussels by Messrs. Baron de Loé, A. Rutot, and E. Rahir. The partial results of these explorations were published in 1911.[1] In 1912 the archeological remains from the cave and terrace of Spy were studied by Abbé Breuil and R. R. Schmidt. The results are published by Abbé Breuil in the Revue anthropologique of 1912,[2] and by Schmidt in his large and meritorious work on prehistoric archeology. Abbé Breuil reached the following conclusions:

> . The terrace of Spy presented the following layers from below upwards:
>
> 1. An old Mousterian layer, with numerous crudely chipped flakes, together with "coups-de-poing."
> 2. Layer of Upper Mousterian with typical, very well worked flints, and with human burials; difficult of separation from superimposed accumulations.
> 3. Typical Aurignacian, and of its middle phase.
> 4. Final Aurignacian with all transition to the Solutrean, and possibly a little of the latter.

M. Breuil believes that the Mousterian types found in the Aurignacian deposits represent introductions by human or animal agencies, rather than true survivals.

DESCRIPTION OF THE SPY SKULLS AND BONES

In their memoir of 1887[3] on the subject, J. Fraipont and Lohest give a detailed description, with the principal measurements, of the

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[1] Baron de Loé et E. Rahir. Nouvelles fouilles à Spy. Bull. Soc. d'Anthrop. de Bruxelles, 1911.

[2] Breuil, Abbé H., Remarques sur les divers niveaux archéologiques du gisement de Spy (Belgique). Rev. anthropologique, 1912, Vol. 22, pp. 126-129.

[3] Arch. de Biol. (Gand), Vol. 7, 1887.

Spy remains; and the main part of these are repeated by Fraipont in 1891[1] (and also more or less on other occasions; see bibliography). In 1888, Fraipont published an interesting additional study on the tibia,[2] in which he shows particularly the considerable inclination backward of the head of the bone. In 1912 and again in 1913, Charles Fraipont, son of Julien, published valuable studies on the astragalus of the men of Spy, with many comparisons.[3] Finally, in 1927, Mlle. Leclercq published a valuable memoir on the curvature of the femur in the Spy and other early, as well as later, femora.[4] Less directly, the Spy remains are dealt with, as has already been mentioned, by all the students of early human remains (see final bibliography).

J. FRAIPONT'S DATA

The principal observations and measurements on the two skeletons by J. Fraipont, as published in his joint memoir with Lohest,[5] are arranged in the following tables. They are remarkable for their faithfulness, though taken by one who was not a professional anatomist or a trained anthropologist. Unfortunately, as will be seen later, there has been a confusion of the bones of the two skeletons.

AUTHOR'S NOTES AND CRITICAL REMARKS

Considering the animal and archeological remains associated with the human skeletons, together with the absence of disturbance in the superimposed more recent layers, Lohest believed himself justified in referring the Spy remains to the Mousterian period; and the deductions of Fraipont, based on the study of the skeletal remains themselves, were that they belonged to Neanderthal man. Since then the Spy remains have received more or less careful consideration by every student of early man, and the above classification was found to need no radical revision.

What remained of the Spy skeletons was preserved, before the German invasion of 1914, in the collections of the University of Liége, where, thanks to the courtesy of Messrs. M. Lohest, Charles

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[1] Les Hommes de Spy, C. R. Cong. Intern. Anthrop. et Archéol. Préhist., 28 pp., Paris, 1891.

[2] Rev. d'Anthrop., 16 pp., Paris, 1888.

[3] Bull. Soc. Anthrop. Bruxelles, Vol. 31, 50 pp. 1912; Dis. inaug., Univ. Liége, Bruxelles, 66 pp., 1913.

[4] Trav. Lab. Paléon. et Anthrop. Univ. Liége, Vol. 1, 63 pp., 1927.

[5] *Op. cit.* See also his "Essai de reconstitution des rapports de la face avec le crâne chez l'homme fossile de Spy." C. R. Assoc. Anat. Liége, pp. 11-13, 1903.

SPY SKULLS: OBSERVATIONS ON THE ORIGINALS

J. Fraipont[1]

	Spy No. 1	Spy No. 2
Outlines from above and side	Much like those of the Neanderthal skull	Somewhat broader and more vaulted
Frontal bone	Shortest and lowest known	Less low and sloping; surpasses the mean Neanderthal form and size
	Poorly developed in length as well as breadth	Somewhat better
Supraorbital arches	As in Neanderthal, but slightly less thick	Approach that of Neanderthal
Glabella	Slightly depressed	No depression
Depression above supraorbital arches	Very marked	Less marked
Temporal fossae	Anterior part much depressed	
Parietals	Relatively better developed than the frontal	Relatively better developed than the frontal
	Flattened in posterior half	Flattened in posterior half
Temporal lines	Not near sagittal suture	Not near sagittal suture
Temporal bones	Low squama, low arched	Low squama, low arched
	Robust petrous parts	Robust petrous parts
Zygomae	Very strong, differ in form from modern	
Occipital	Strongly protruding, just as as in Neanderthal	Less so
	Inferiorly squama very sloping and flattened	Inferiorly squama very sloping and flattened
	Indications of transverse occipital crest	Indications of transverse occipital crest
External occipital protuberance	Depression	None
Internal occipital protuberance and grooves of sinuses.	Lower and more forward than in modern skulls	Lower and more forward than in modern skulls
Brain:		
Anterior lobes	Poorly developed	Somewhat better
Middle lobes		
Posterior cerebral lobes	Well developed, as in modern dolichocephals	Well developed, as in modern dolichocephals
Cerebellar fossae	Less deep and extending less posteriorly than in modern skulls	Less deep and extending less posteriorly than in modern skulls
Upper jaw	Stout and high alveolar process	Even stouter than No. 1
	Low nasal process	
Malars	Strong, lower border, stout	

SPY SKULLS: OBSERVATIONS ON THE ORIGINALS

J. Fraipont—Continued

	Spy No. 1	Spy No. 2
Lower jaw:		
Body	Very robust, very high No chin	Even stouter
Lower border	A surface, especially anteriorly, not a border	
Teeth:	As in modern inferior groups, incisors small, canines moderate	As in modern inferior groups, incisors small, canines moderate
	Molars: M1, 5 cusps	Molars: M1, 5 cusps
	M2, 4 cusps	M2, 4 cusps
	M3, 4 cusps	M3, 4 cusps
Clavicles	Nothing peculiar	
Scapulae (fragments)		Nothing peculiar
Humeri	Strong, short	Stronger than in 1
Radii	Slender	Slender
Ulnae	Marked curvature	Marked curvature
Femora	Robust	Even stronger
	Voluminous extremities (lower condyles enormous), shaft almost cylindrical, forward curvature accentuated, linea aspera nearly absent, lower articular surfaces extend less forward and more backward than in modern bones	The same; resembles strikingly the Neanderthal femur
Tibiae	Short, stout. Shaft less prismatic than in modern bones, borders dull. Extremities, especially the lower, relatively voluminous. Head so inclined backwards that articular facets face upward and backward. (Judges that limbs were not held straight, but somewhat bent forward at the middle)	
Calcaneus	Short, robust	Short, robust
	Prominence of heel short	Prominence of heel short
Fibula, astragalus, patella and other parts	Nothing particular	Nothing particular
Sex	Female (identified as male by Hamy, Schaaffhausen, Topinard, Virchow)	Male (very plainly)
Race	Feels justified in concluding that they belong to the same race—the Neanderthal	

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[1] Les Hommes de Spy. C. R. Cong. intern. Anthrop. et Archeol. Prehist., 28 pp., Paris, 1891.

Fraipont, and J. Sérvais, the writer was enabled to examine the originals for the first time in 1912. During the invasion, the remains, the property of M. Lohest, were secreted by him in his home at the bottom of an old chest, and, though searched for, remained safe. Here, in the presence of the late owner, the writer studied the remains the second time in 1923, and finally, in 1927, thanks to the courtesy of the sons of Lohest, he was enabled to examine the originals, still in the Lohest home, for the third time. In 1923, through the aid of Professor A. Rutot and his assistant, the writer also visited the cave.

THE SPY CRANIA

MEASUREMENTS ON THE ORIGINAL

(FRAIPONT[1])

	Spy No. 1	Spy No. 2
Vault:	*cm.*	*cm.*
Length max	20.0	19.8
Breadth max	14.0	15.0
Cranial index	*70.0*	*74.8*
Cranial circumference	58.0	54.0
Diam. frontal min	10.4	10.6
Diam. frontal max	11.4	11.7
Diam. external biorbital (max. breadth supraorb. arch)	12.2	12.0
Closest approach of upper temporal line to sagittal suture	....	r. 6.5 l. 6.0
Height of supraorb. arch, mean	1.6	1.5
Thickness of skull bones	up to 0.9	up to 0.9
Face:		
Upper jaw, height, alveolar point—nasal spine	2.8	....
Lower Jaw:		
Height at symphysis	3.8	....
At M1	3.3	...
At M2	3.3	....
Thickness at symphysis	1.5	....
At M2	1.4	....
Tibia:		
Length	32.0	....
At middle:		
Circumference	9.0	....
Diam. antero-post	3.3	....
Diam. transverse	2.4	....

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[1] Fraipont, J., Les Hommes de Spy. C. R. Cong. Intern. Anthrop. et Archeol. Préhist., 28 pp., Paris, 1891.

The skeletons are generally known as No. 1 and No. 2. To No. 1 Fraipont and Lohest attributed:

A vault of a skull;
Two portions of the upper jaw, with the three right molars, the two right premolars, the left canine and left lateral incisors;
A nearly complete lower jaw, with all (16) of its teeth;
The left clavicle;
Right humerus, which has lost its upper epiphysis, and the shaft of the left humerus;
Left radius, without lower epiphysis;
The proximal extremities of the two ulnae;
The nearly entire right femur;
Complete left tibia; and,
The right calcaneum.

The parts attributed by the two authors to the second subject are:

The vault of a skull;
Two portions of the upper jaw with twelve teeth;
Two fragments of the lower jaw with the molar teeth;
Loose teeth belonging to the lower jaw;
Fragments of the scapulae of two humeri without upper extremities;
The shaft of the right radius;
The proximal two-thirds of the left femur;
The left calcaneum; and
The left astragalus.

Besides the above, there are 7 vertebrae, a right patella, 24 fragments of ribs, and 11 bones of hands and feet, with some pieces, about which it seemed impossible to say to which skeleton they belonged.

A repeated critical examination of the specimens leaves a serious doubt as to the accuracy of the above distribution. No photographs or sketches were made on the spot; the bones were not marked, and have evidently become mixed up, their distribution being decided upon later. The specimens indicate very strongly different relations. The right femur, the tibia, and the two stronger ulnae do not harmonize with the relatively weak arm bones and clavicle of No. 1. They harmonize perfectly, on the other hand, with the bones of the male skeleton No. 2 and must, the writer feels, be attributed to this skeleton. The true identification of the parts appears to be as given on page 189.

This identification removes many difficulties, makes the material much more intelligible, and the deductions on it of more value. Strong evidence for the correctness of this reclassification is offered by both the femur and the tibia that were attributed to skeleton No. 1. Skull No. 1, as is shown by its sutures and by the teeth, belongs to a fully adult individual of somewhat advancing years. Skull No. 2 indicates a younger person. Now both the femur and the tibia attributed to No. 1 show still, in proper light, traces of the union of the knee epiphyses. This is incompatible with the indicated age of No. 1, but would fit much better with that of No. 2.

It is strange that so many parts of the skeletons are missing. One must surely assume that everything possible was done at the time of the find to recover all the bones; yet the state of preservation of the parts present is so good, there are so many of them, and they are so distributed as to the skeletons, that the possibility of some of the missing parts, at least, having escaped detection and being still somewhere in the débris of the excavation, cannot be excluded.

THE SPY SKELETONS

(As Identified by Hrdlička)

Skeleton No. 1	Skeleton No. 2
Sex—Weak male or a female.	Male.
Age—About 35 years.	About 23 years.
Parts belonging to it:	Parts belonging to it:
Smaller skullcap.	Larger skullcap.
Portion of right maxilla.	Two portions of upper jaw.
Lower jaw (complete except for damage to rami).	Two pieces of lower jaw.
Sound loose teeth (probably).	Loose teeth.
The two weaker humeri.	The two strong humeri.
Two damaged radii.	
Head of a weak ulna.	The proximal parts of two strong ulnae.
Weak clavicle.	Parts of the two scapulae.
	A nearly complete right and proximal half of the left femur.
	Complete left tibia.
Two fragments of fibula (probably).	Lower fifth of right fibula.
	Left patella.
	Right calcaneus.
	Left astragalus.
	Portion of sacrum.
Some small bones and fragments.	Fragments and small bones.

All the skeletal parts show an advanced state of mineralization. In color they range from brownish to grayish, skull No. 1 representing the former and No. 2 the latter shading; the teeth, however, are white, with yellowish roots, much as in crania from late burials.

The two skulls are plainly normal specimens, free from disease or deformation.

In age, No. 1 was an adult of about 35 years, No. 2 had just reached the adult stage.

As to sex, were it not for the heavy supraorbital arch, No. 1 would be identifiable as a female. Such identification would conform with the characteristics of all the bones that may definitely be attributed to this subject, except the skull, and even this is rather feminine except in the lower frontal region. The upper as well as the lower jaw belonging to this skull is, for early man, rather weak, the teeth rather small; the humeri are feminine rather than masculine, both in their strength and in the proportion of the distal extremity; the head of the radius and that of the ulna, belonging to this subject, are quite feminine, and so is the piece of the clavicle. The subject may however have been a short and weak male.

Morphologically the two skeletons, more particularly the two crania, show features of such interest and importance to anthropology that they deserve all possible attention. The vault of skull No. 1, and the skeletal parts of both individuals, are thoroughly Neanderthal in character; but the jaws, teeth, and the vault of skull No. 2 represent nothing less than a bridge from the Neanderthal type to recent man.

THE CRANIA

The vault: Looked at from above or from the side, or from the front or back, the two Spy skulls show without question the same identical basic type, which is the type of the Neanderthal skull and Neanderthal crania in general. But there is a vast difference in the development of the two crania. The supraorbital arches, while much alike, are somewhat heavier and somewhat more protruding forward in skull No. 1 than in No. 2. In No. 1 they are of nearly the same thickness throughout; in No. 2 they distinctly diminish in thickness from their median third outward. In both cases there was a perceptible depression for the glabella, so that viewed from the front there are really two supraorbital arches rather than one continuous arch, though connected below the glabella. The glabellar depression is broader in No. 2 than in No. 1, and the superior outline of the supraorbital ridge presents more of a curve, sloping gradually downward, in its outer half than is the case in No. 1. The superior border of the orbits, dull in No. 1 is sharper and better defined in No. 2.

In all of its characters the supraorbital arch of No. 1 is much like that in the Neanderthal cranium, though less thick; in No. 2 the arch, while still of the same type, is distinctly advanced toward modern forms. The depression between the supraorbital arch and the forehead is very marked in No. 1, being in general even more hollowed out than in the Neanderthal skull; in No. 2 there is still a depression, but this is more of the nature of an angle between the upward sloping surface of the arch and the rising frontal bone, than such a hollow as in skull No. 1. The forehead and frontal region of No. 1 is decidedly lower and smaller than in No. 2. It is slightly lower and perceptibly smaller than it is even in the Neanderthal specimen. From the top, both of the Spy skulls present a distinctly ovoid outline; in No. 1, however, this ovoid is very perceptibly narrower throughout than it is in No. 2. The broadest part of the ovoid corresponds in each case to the posterior third of the lower half of the parietals. The outline of the Neanderthal skull is much like that of Spy No. 1, though the latter is more markedly narrowed in the frontal region. The forehead and whole vault of No. 2 are markedly higher than they are in No. 1, reaching proportions that could be duplicated, save for the supraorbital arch, in many modern mesocephalic skulls.

The temporal lines in skull No. 1 are poorly marked, in No. 2 very distinct; but in neither skull are they very rough or elevated, and in neither do they reach over approximately the middle of the parietals.

The sagittal region is but very slightly raised so that the outline of the vault from side to side would approach an oval in No. 1 (where slight keeling exists), and is quite oval in No. 2. The occipital region of No. 1 is typically Neanderthal, *i. e.,* flattened from above and below with a medium protrusion in the middle; in No. 2, while there are still distinct reminiscences of this type, the development is already much nearer to that in modern skulls. The temporal region in No. 1 was evidently rather flat and narrow; in No. 2 it is about as in average modern skulls. Both skulls, but particularly No. 2, present a mild continuous occipital torus which extends towards the lambdoid suture and along this downward toward the mastoid region. The cranial sutures in both skulls, particularly the sagittal and the lambdoid, are much simpler than they are in average modern crania. In general the Spy No. 2 skull is larger and appears more masculine than No. 1. The mastoid and basal parts of the two skulls are largely deficient; what remains shows a number of peculiarities, particularly in the left post-auricular region of skull No. 2.

Endocranially, skull No. 1 shows that the anterior part of the brain was narrow, low, and nearer to the keeled type than it is in the brain of today. The left occipital lobe was perceptibly longer and more pointed; the right lobe was slightly shorter but somewhat broader and higher. In skull No. 2 the left hemisphere was perceptibly longer.

UPPER JAW OF SKULL NO. 1

Present, the lower portion of the right maxilla from the alveolus of the median incisor to the third molar. The bone is relatively rather slender, not thicker than in modern skulls. There was evidently but a moderate alveolar prognathism, comparable to that of many of the skulls of the yellow-brown races of today. The lower border of the nasal aperture is well defined and slightly dull—not as sharp as in whites, nor as dull as in some recent primitive skulls. The teeth are in very close apposition; and the M1 and M2 show already a distinct obliquity of their transverse (linguo-labial) axis, which is characteristic of and often carried further in modern whites. The palate was evidently of about the average depth of today. The teeth of both the upper and lower jaw show moderate to medium wear, the anterior teeth being more worn than the molars.

MEASUREMENTS OF THE SPY CRANIA

(By Hrdlička)

	No. 1		No. 2	
	1912	1927	1912	1927
Length max., from glabella	20.3	20.25	20.0 (?)[1]	near 19.9
Length max., from ophryon	18.8	18.9	18.6	18.7
Breadth max.	14.7	14.6	15.4	15.4
Cranial index	*72.4*	*72.1*	near *77.0*	*77.4*
Height, floor of auditory meatus line—bg	....	near 11.8	....	near 12.3
Diam. front. min.	10.3	10.2	10.9	10.9
Diam. front. max.	11.7	near 12.4	12.5	12.6
Nasion-bregma diam.	10.6	....	?	....
Glabella (center)—bregma	9.8	....	near 10.9	....
Bregma-lambda diam.	11.3	....	10.8	....
Thickness of left parietal along and 1 cm. above squamous suture	6–8 mm.	....	5–8 mm.	....
Thickness of frontal, at eminence	9 mm.	....	8 mm.	....
Face: Breadth max. of supraorb. arch	12.2	....	12.3	....
Height of what may be called forehead, near	2.5	....	3.0	....
Endocranial length max. r.	17.2	....	17.0[2]	....
l.	17.3	....	17.2	....

---

[1] Glabella wanting.

[2] The brain cavity is markedly broader, higher, and in general more spacious than that of No. 1, but measurements were impracticable.

LOWER JAW OF SKULL NO. 1

The lower jaw attributed to skeleton No. 1 appears to have been somewhat misrepresented in earlier publications. The bone is quite as slender as the average lower jaw of man of today. The height of the body, though considerable if this was the jaw of a female, falls easily within the modern male limits; and the shapes and sizes of the teeth are much like those of modern whites. On the other hand the specimen shows a number of interesting primitive and in one or two respects peculiar features.

There is no chin eminence, yet there is a slight broad chin with a moderate depression above. Were it not for the fact that the alveolar process protrudes somewhat forward, the chin formation would be more distinct. It is possible to duplicate these features among some primitive jaws of today. The mental foramina are situated further back than in modern jaws, being directly beneath the first molars. The lower border of the jaw is somewhat thicker and flatter in the anterior third (digastric insertion) than it is in the jaws of the white man of today. The digastric portion presents a low flat topped arch, reminding one somewhat of the much more marked condition in the Mauer mandible; more or less marked traces of such an arch are also present in modern jaws. The teeth look feminine. They are perceptibly smaller than those of some male whites of today. The alveolar process, from a line touching the rear of the third molars to the most anterior point of the alveolar border in the incisor region, measures but 4.9 cm., which is below the same measurement in many modern jaws. The external breadth of the dental arch is 7.1 cm., which is broader than in the majority of female white jaws of today but is equalled or even exceeded in some of those of the males; and this measurement is equalled or exceeded in numerous cases among more primitive whites and other peoples.

Notwithstanding the above, the Spy jaw as a whole is larger anteroposteriorly than the jaws of modern man. This is due to the extension of the body of the jaw on each side beyond, *i. e.,* backward of, the dental arch. There were evidently not only fairly broad ascending rami, but also a considerable space (approximately 10 mm.) between the third molars and the anterior border of the rami. This space is generally absent or very reduced in modern jaws, and in not a few cases the third molars lie actually partly behind the anterior border of the ascending branches. It is an early character.

Additional peculiarities are observable on the lingual surface of the bone. The anterior portion of the surface shows in its upper half a fairly marked convexity, a remnant of the thickness and convexity of these parts in still earlier mandibles. Remnants of this convexity are still met with occasionally in modern skulls.

The inner aspect of the lower jaw anterior to the second molars gives a sense of spaciousness, with the inner symphyseal line more vertical than in most modern jaws; and the axes of the canines and incisors are somewhat evergent, rather than vertical or invergent as they are in most modern jaws.

The mylohyoid ridge on each side is markedly developed and runs far forward (to beneath the posterior premolars); beneath it is a marked, long triangular fossa which is indicated more or less but never developed to such a degree in modern mandibles. This fossa is especially deep on the left side of the Spy jaw.

The molars on the right are all of very nearly the same size; on the left the M3 is slightly broader than M1 and M2. The following additional measurements will show the moderate proportions of the bone and the teeth:

MEASUREMENTS OF THE LOWER JAWS

(By Hrdlička)

	Skull 1		Skull 2	
	1912	1927	1912	1927
Diam. bigonial, near	....	10.0	....	....
Height at symphysis	3.55	3.65	....	....
Height between M1 and M2	....	near 3.20	....	....
Thickness at symphysis, without genial tubercles	1.3	....	....	....
with the tubercles	1.5	....	....	....
Thickness of body between M1 and M2 r.	1.3	....	....	....
At M1 r.	1.3	....	....	...
l.	1.3	....	1.4	....
At M2 r.	1.5	1.5	....	....
l.	1.4	1.4	....	....
At M3 r.	1.7	....	....	....
l.	1.6	....	1.7	....

UPPER JAW OF SKULL NO. 2

Two fragments, stronger than in No. 1.

LOWER JAW OF SKULL NO. 2

Present, two pieces, chin portion wanting. Both the jaw and the teeth are stronger and larger than those of No. 1. The body of the bone was also higher than that in No. 1. The fragments do not permit of much description—the most interesting parts of the specimen are wanting. Of the molars, on the right M1 and M3 are alike in size, M2 appears slightly smaller than both; on left M1 and M2 are alike, M3 is slightly larger than either.

MEASUREMENTS OF THE TEETH[1]

	Skull No. 1			
	Median Length		Maximum Breadth	
	Fraipont	Hrdlička	Fraipont	Hrdlička
	mm.	*mm.*	*mm.*	*mm.*
Lower M1, means of r. and l.	10.0[2]	11.0	10.5	11.0
M2, means of r. and l.	10.0[2]	11.0	10.0	11.0
M3, means of r. and l.	11.0[2]	10.6	11.0	10.8
Total median length of the three molars in position[3]	....	33	....	33
	Skull No. 2			
Lower M1, means of r. and l.	11–11.5	11.35	11–11.5	11.75
M2, means of r. and l.	11.0[2]	11.35	11.0	11.5
M3, means of r. and l.	11–12	11.8	11–12	11.75
Total median length of the three molars in position[3]	....	35	....	36

[1] See also writer's "New Data on the Teeth of Early Man and Certain Fossil Anthropoid Apes." Amer. Journ. Phys. Anthrop., Vol. 7, p. 109 et seq., 1924; but, due to an error, the Spy No. 1 throughout that article is Spy No. 2, and vice versa.

[2] These measurements are certainly a trace too small. This is probably the length maximum, while those taken by the writer are the median lengths (see above paper); the maximum length is often slightly in excess of the median one.

[3] This total length is often a trace higher than the sum of the individual lengths due to some bulging of the crowns which does not become included in the individual measurements.

THE BONES OF THE SKELETONS

Skeleton No. 1

As seen before, the only parts that can be definitely attributed to this skeleton are two imperfect humeri, the head of a left ulna, and a portion of a left clavicle. It is very probable, however, that the two radii belonged also to this individual, and they will be described in this connection.

The humeri.—Right, the lower two-thirds; left, the shaft without the extremities. The bones are of moderate strength and have belonged evidently to either a weak male or more probably to a female. The distal end in the right bone is quite feminine.

The shafts of the bone differ in shape from modern humeri in that both the mesial and the lateral surfaces are distinctly convex, much alike, and converging forward to a relatively high ridge for the latissimus dorsi muscle, from which a ridge for the pectoralis major diverges upwards from about the site of the deltoid tuberosity, which is undeveloped. The musculo-spiral groove is hardly noticeable. The posterior surface of the shaft, especially above the middle, is narrow, and above the middle becomes also somewhat unevenly convex. The lower fourth of the shaft is relatively decidedly higher (antero-posteriorly) than it is in modern bones of similar dimensions. There is no perforation of the fossa (right), and no trace of a supracondyloid process. The lower articular part of the right bone resembles in nearly all essentials that of a female humerus of today, the only exceptions being that the trochlea is relatively slightly narrower from side to side, that its cross section (lateral) is but very slightly convex rather than markedly so as in modern bones, and that its mesial border is rather high. The depression above the capitulum is deeper than is usual in many, but not all, modern bones; and the olecranon fossa is both markedly deeper and more spacious than it is in modern humeri of similar size.

		cm.	
Measurements		r.	l.
At middle of shaft, antero-post. diam		2.2	2.1
Lateral diam.		1.4	1.4
Olecranon fossa:			
Height max.	20.0 mm.		
Breadth max.	28.0 mm.		
Breadth of articular facet:			
(in middle of its anterior aspect)	38.0 mm.		

The radii.—The two radii present belong more likely, it seems, to this skeleton than to No. 2. They were of moderate length, and of good feminine (or weak masculine) strength. The head of the left bone is decidedly feminine. Its maximum diameter is only 19 mm. The neck is narrow. The tuberosity and the shaft resemble those in modern bones, but the shaft shows a very marked curvature outward, just as in the Neanderthal radius, which is not equalled under normal conditions among modern bones.

The ulnae.—The head of the left ulna that clearly belongs to this skeleton is of feminine proportions, and so far as it is preserved it falls in every respect within the range of variation of the modern bones.

The clavicle.—The clavicle was slender, its shaft near the acromion rather angular. The fragment is too small to permit of other determinations.

The fibulae.—There are two pieces of the shaft of the fibula that may belong to skeleton 1; they are both of but moderate strength.

Skeleton No. 2

The humeri.—Clearly a pair, and both masculine; the right very perceptibly the stronger at all points. The upper fourths are wanting. The shafts resemble to a considerable degree those of No. 1, but the convexity of the mesial and lateral surfaces is less marked, and the posterior surface is flat through a very large part of its extent. The relative height of the lower portion of the shaft is less marked than in the humeri of No. 1, and approaches closely that of modern male humeri of similar dimensions; nevertheless there is a trace of such relative highness of this part in the right bone. The deltoid tuberosity is again poorly developed, the latissimus and pectoralis ridges well marked; the bicipital and muscular spiral groups are better represented than they are in humeri of No. 1. The lower end and the articular facet are in nearly all particulars as in man of today; only the olecranon fossa is larger, especially broader and deeper. There is again as in No. 1 a marked depression above the capitulum, on each side. No trace of a supracondyloid process appears on either bone. Perforations of the olecranon fossa: Right, one small and one minute; left, two small with two minute.

	cm.	
Measurements	r.	l.
Middle of the shaft: antero-post. diam	2.5	2.25
Transverse diam.	1.75	1.5

The ulnae.—Present, head of right, upper two-fifths of left. Bones clearly a pair, and masculine. Olecranon process decidedly more massive than in whites of today. The horizontal part of the greater sigmoid cavity is very perceptibly shallower than in modern bones. The neck is strong, especially on the right side. The shaft of the left bone as far as preserved shows quite a different shape from that in the modern ulna; the latter is prismatic, the former approaching a biconvex.

The scapulae.—Pieces only, of two scapulae, right and left, probably of No. 2. Right piece: Glenoid cavity shallow, border very dull. Left: Glenoid shallow, border less dull.

The femora.—The left femur, except for damage to the great trochanter, is in general very near in all its characteristics to that of the Neanderthal skeleton. It is slightly shorter; but it presents the same huge head and stout neck, a similar condition of the minor trochanter and of the gluteal ridge, the same curvature forward of the whole shaft, the same strength and shape of the shaft, the same but slightly developed linea aspera, a similar though less marked suprapopliteal convexity, and a considerable similarity of the condyles.

It differs from the Neanderthal femur by a somewhat more marked subtrochanteric flattening; by the absence of the higher patellar depression, with the presence of a deeper depression directly above the patellar surface; by the lesser convexity of the popliteal surface; by somewhat broader and stouter condyles, with broader patellar surface; by somewhat duller anterior ridges of the condyles; and by a slightly greater torsion. These are all, however, rather secondary differences; the essential characters of the two bones are much the same.

The left femur, represented by its upper half, and formerly attributed to skeleton No. 1, is plainly a mate of the right femur and belongs with it to the male skeleton No. 2. It has much the same strength, same shape, same features. The writer's measurements of the two bones are given on the following page.

The tibiae.—The left whole tibia, the only one present, attaches itself clearly, by its size, strength, and other characters, to the two femora, and with them to skeleton No. 2. A detailed study of the bones leaves no possible doubt on this score. The bone, as already established by J. Fraipont, is especially characterized by the marked inclination backward of its head. This inclination is considerably more marked on the mesial than on the lateral side of the bone. The shaft of the bone is remarkably straight, in every way. The shape of the shaft is that of a lateral prism. (Hrdlička's type 2).[1] The bone is remarkable by its shortness and strength. It is particularly stout in the upper and lower fourths of the shaft. The mesial articular surface is decidedly more inclined backwards than in the modern tibia; and the lateral surface is shallower than that in modern bones. The malleolus is broader than in modern bones and decidedly stouter. The lower articular surface differs from that in modern bones in being relatively broader laterally and narrower antero-posteriorly, and in extending more obliquely onto the malleolus. Otherwise the details of the bone are much like those in recent man.

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[1] Hrdlička, A., Typical Forms of Shaft of Long Bones. Proc. Assoc. Amer. Anat., pp. 55-60, New York, 1900.

———, Anthropology. Wistar Institute, 1919.

LONG BONES

	Skeleton No. 1								Skeleton No. 2							
	Humerus		Radius		Femur		Tibia		Humerus		Radius		Femur		Tibia	
	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.
Type of shaft at middle	I surfaces sm. convex	I	....		cylindr.-oval	....	....	1–2	I anterior surface sm. convex	near I	....		....	near cylindr.	....	
Length max.	....		....		42.6	....	....		....		....		....		....	
bicondylar	....		....		42.4[1]	....	....	33.3[1]	....		....		....		....	
in position, less spine	....		....		....		....		....		....		....		....	
At middle: Circumference	2	2	....	2	10.1	....	....		2	2	near 2	....	....		....	
antero-post. diam.	1.4[2]	1.4[2]	....	1.15	2.9	....	....	3.4	1.75[2]	1.5[2]	1.25	....	....	2.9	....	
transverse diam.	2.2[3]	2.1[3]	....	1.6	2.9	....	....	2.35	2.5[3]	2.25[3]	1.6	....	....	3.0	....	
Index	....		....	*71.9*	*100.0*	....	....	*69.1*	*70.0*	*66.7*	near *78.0*	....	....		....	
At upper flattening:																
Diam. max.	....		....		3.6	....	....		....		....		....	3.7	....	
Diam. min.	....		....		2.5	....	....		....		....		....	2.5	....	
Index	....		....		*69.4*	....	....		....		....		....	*67.6*	....	
Head:																
Diam. max.	....		....		5.45	....	....		....		....		....		....	
Diam. min.	....		....		....		....		....		....		....		....	

Long Bones—Continued

	Skeleton No. 1								Skeleton No. 2							
	Humerus		Radius		Femur		Tibia		Humerus		Radius		Femur		Tibia	
	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.	l.
Neck:																
Diam. max.	....		....		?	....	....		....		....		....	4.0	....	
Diam. min.	....		....		3.0	....	....		....		....		....	3.2	....	
Distal end:																
Breadth max.	....		....		9.2	....	....		....		....		....		....	
Condyles:																
Medial condyle, diam. max.	....		....		6.8	....	....		....		....		....		....	
Lateral condyle, diam. max.	....		....		7.2	....	....		....		....		....		....	
Medial condyle, diam. vertical	....		....		6.5	....	....		....		....		....		....	
Lateral condyle, diam. vertical	....		....		7.1	....	....		....		....		....		....	
Intercondylar notch, depth superiorly	....		....		0.7	....	....		....		....		....		....	

---

[1] From the horizontal, as the bone lies on the table.

[2] Diam. min.

[3] Diam. max.

The fibulae.—Present, about the lower fifth of the right bone. The strength of the bone and also the fact that the union line of the epiphysis is still perceptible, identifies the bone decisively with skeleton No. 2. The outer surface of the lower end is rather bibeveled, rising to a median ridge; and the fossa next to the articular facet is small and shallow. The facet itself seems also to differ from that of modern bones by a greater length from above downwards.

The patella.—The left complete patella, originally identified erroneously as right, doubtless masculine, may be attributed safely to skeleton No. 2. The dimensions and form are close to those in modern man; but the articular area is relatively broad. The upper and outer border shows a moderate notch for the vastus lateralis.

DIMENSIONS OF THE PATELLA

	cm.
Height	4.65
Breadth	5.2
Thickness, max.	2.3

The calcaneus.—Present, the right bone; masculine, and doubtless belonging to skeleton No. 2. The mesial and anterior parts of the bone are badly damaged. Notwithstanding this it is plain that the bone was very stout and very short. The stoutness is particularly marked in the body and the heel, but extended really throughout the bone, so that the articular surface for the astragalus is broader than in modern bones. The shortness of the bone is due practically entirely to the shortness of its anterior portion (the part anterior to the rear facet for the tarsus).

The bone shows a number of interesting particulars. One is the relatively slight development of the medial process and the adjacent border bounding anteriorly the inferior surface of the tuberosity; the second is the marked development of the groove for the long flexor muscle of the great toe; the third is the relative narrowness and shallow concavity of the mesial surface of the body. The articular facets for the astragalus fall within the range of their variation in modern bones—a range known to be extensive.

The astragalus.—The left astragalus, belonging plainly to the above described calcaneus and pertaining with it to skeleton No. 2. The bone, like the calcaneus, is stout but relatively short anteroposteriorly. In details it does not differ greatly from modern bones, except in dimensions and to some extent the form of the articular surface. The lateral groove between the head and the body is, however, less spacious than in modern bones.

The sacrum.—Present, the uppermost segment; it does not appear to have been as yet fully united with the rest of the bone; belongs doubtless to skeleton No. 2. Nothing very distinctive.

CONCLUDING REMARKS

Neither previous publications nor the present volume furnishes a wholly adequate study of the important Spy skeletons. Such a study with extensive comparisons of more recently discovered human materials is still to be made. Furthermore, no endocranial casts of these very instructive skulls have as yet been available.

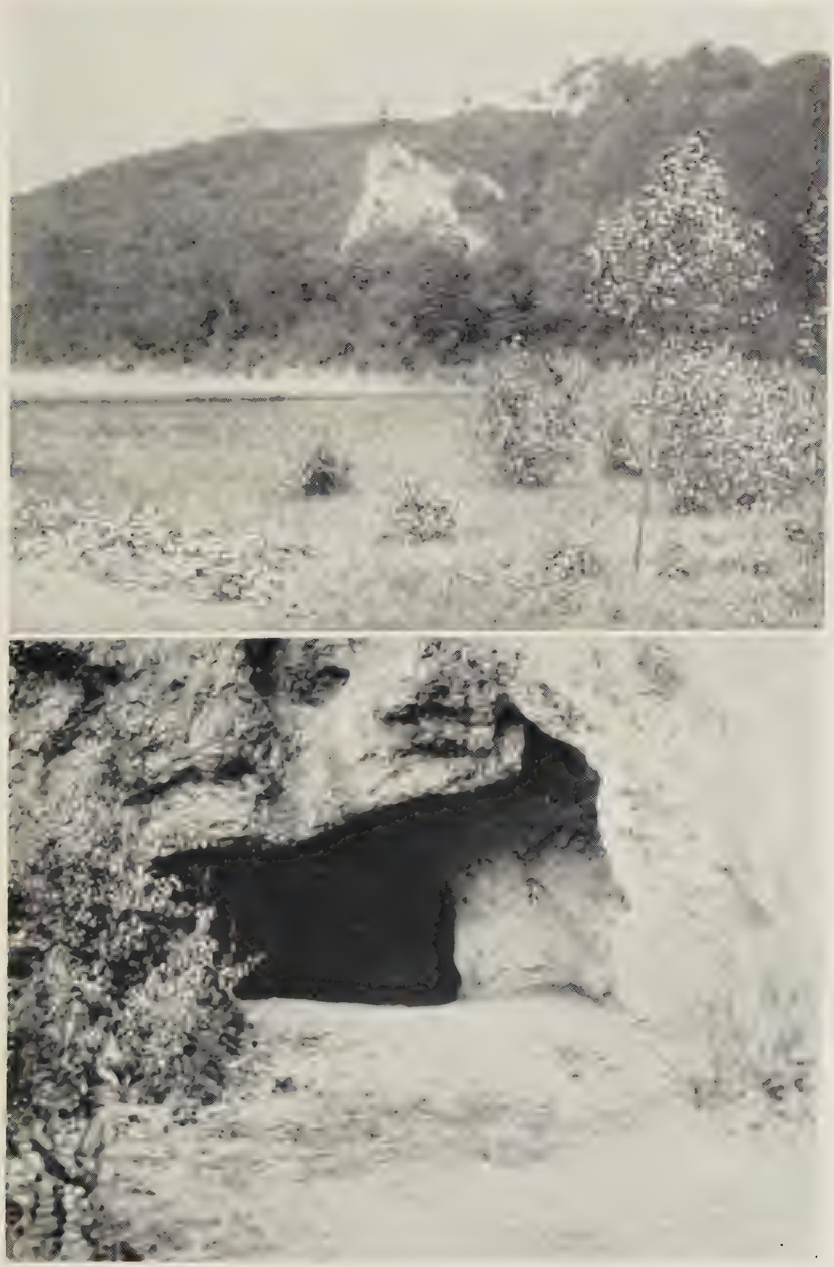
The Spy find is without question the most important ever made in relation to the problem of transition from the Neanderthal to the more modern forms of man. Here in practically one grave, certainly at the same level and under the same associations, are found two skeletons, one of which is in many respects still typically Neanderthal; but the jaws and the teeth of this skeleton, and the skull of the second subject, are far in advance of the Neanderthal stage and correspondingly nearer to modern man. No better demonstration could have been furnished, or could reasonably be wished for, of the transitional potentialities among the later Neanderthal representatives, to which the skeletons evidently belong, towards the modern human type.

The cultural conditions found in the terrace may be of significance in this connection. There is a very strong probability that the two skeletons represented regular intentional burials; and if so, they may well belong to the time of the upper Mousterian, if not even later, deposits.

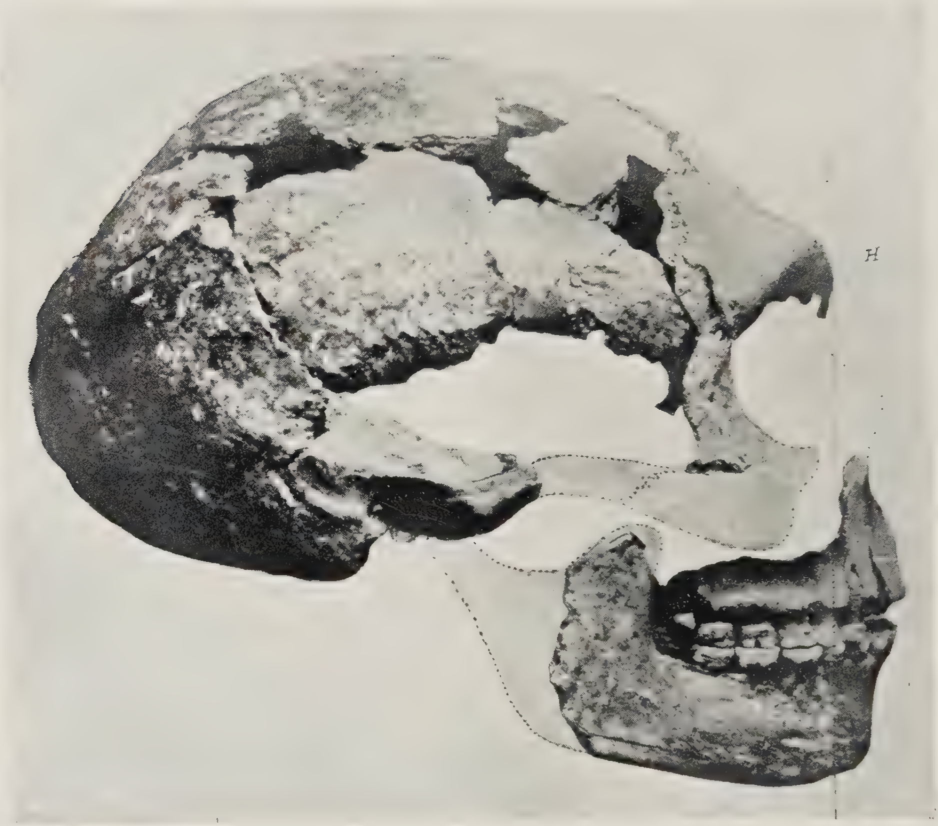
Meanwhile, the precious Spy remains are housed in a private residence, where in a few minutes they could be destroyed by fire, which would mean irreparable loss to science.

THE DILUVIAL MAN OF KRAPINA

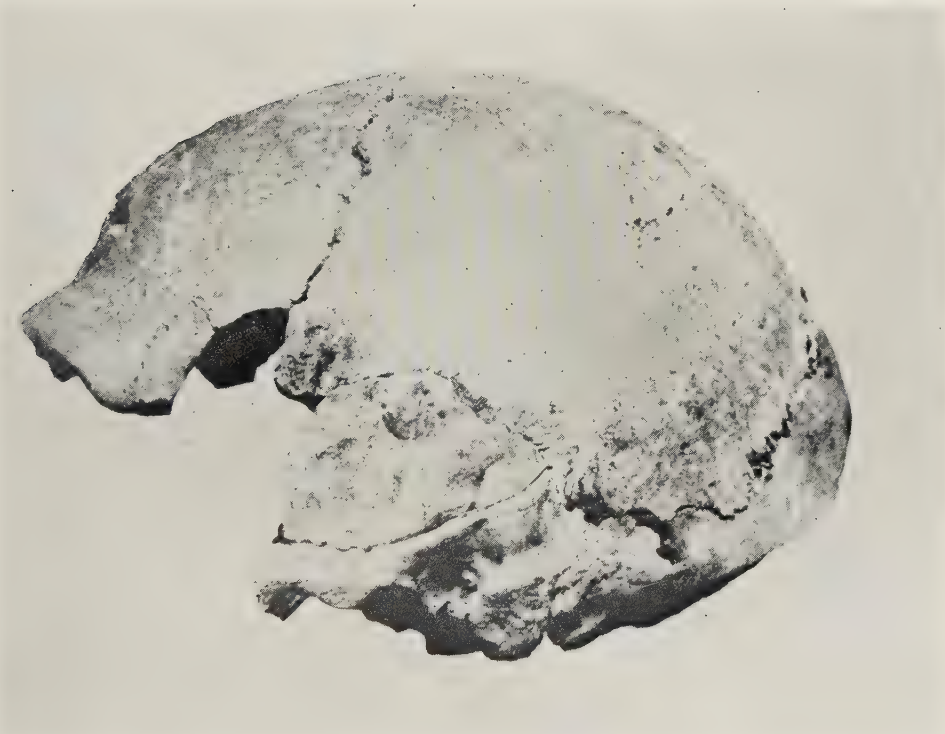
One of the most important finds of the skeletal remains of Quaternary man is unquestionably that of the Krapina shelter, near Zagreb, in northern Croatia. The discovery comprises a whole series of human bones of well-determined geological age, and the remains were not recovered accidentally or by ignorant laborers, but through prolonged, painstaking exploration. The bones themselves are for the most part fragmentary, which is much to be regretted, but they represent, as now estimated, over 20 individuals, and they show on one hand such similarities and on the other such variation of structure, that they are of great value to the student of ancient humanity.



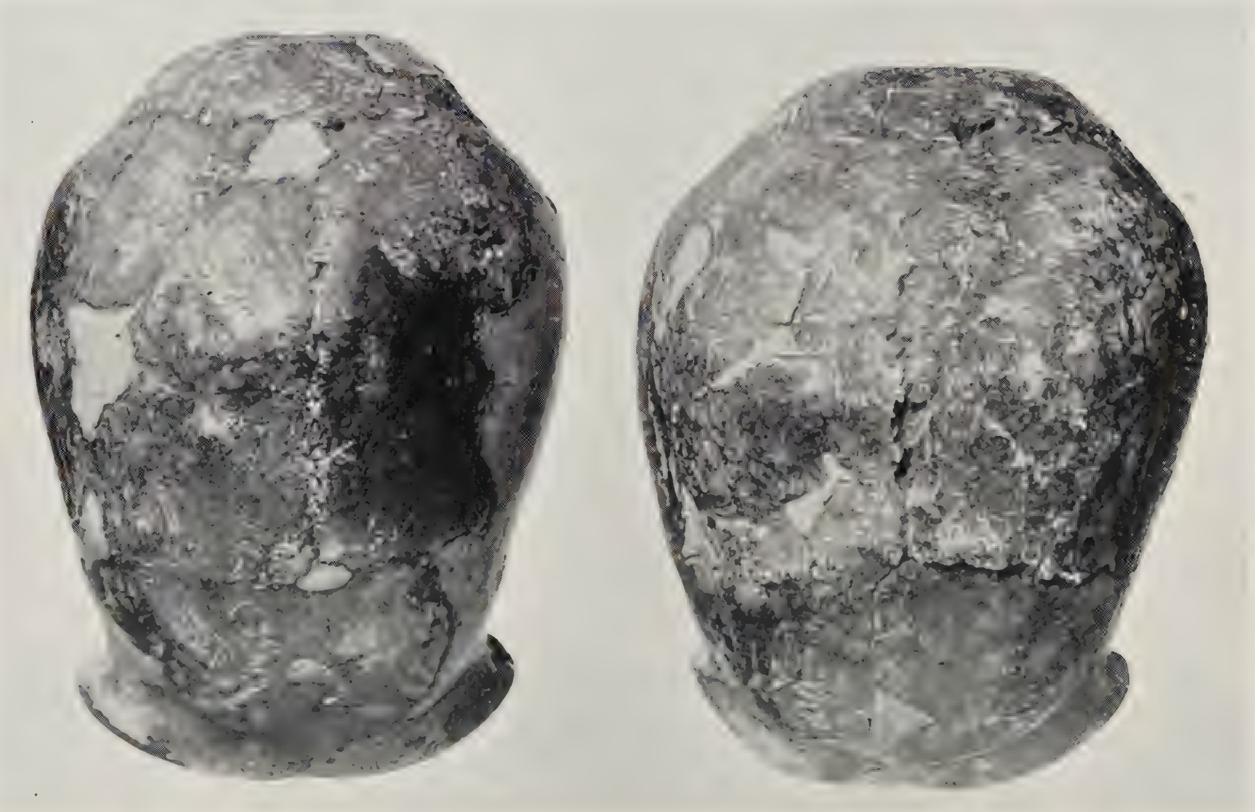
The Spy rock and cave. (Hrdlička, 1923.)



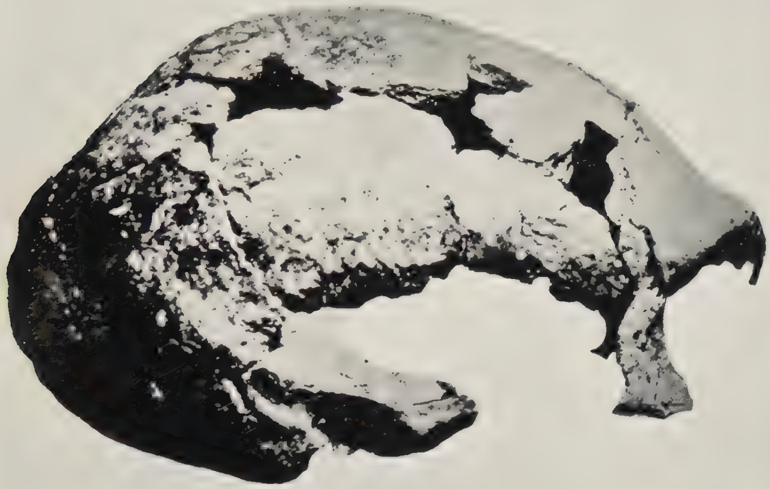
Spy skull No. 1, side view. (After Fraipont.)



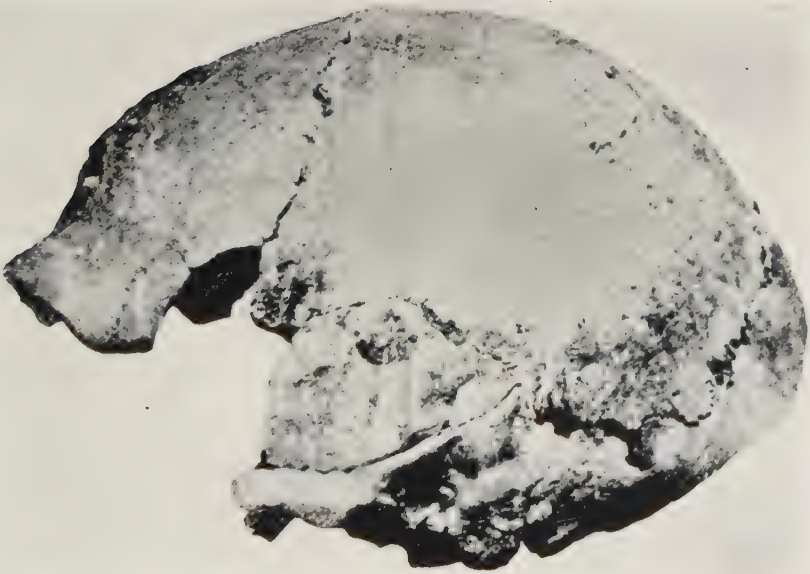
The Spy skull No. 2. (After Fraipont and Lohest.)



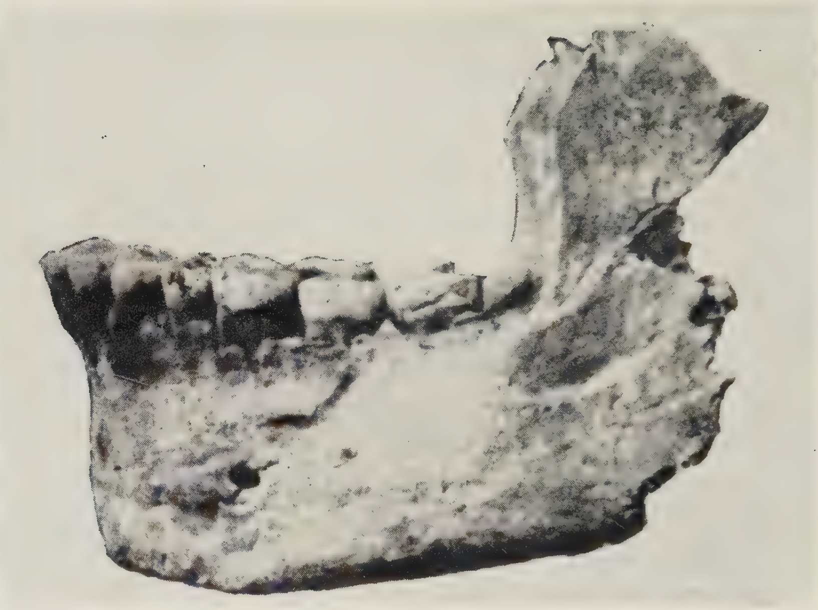
Spy skull No. 1 (left) and No. 2 (right). (Hrdlička.)



1. Spy skull No. 1.



2. Spy skull No. 2, showing contrast in form of vault.



The lower jaw of Spy skull No. 1. (After Fraipont and Lohest.)

The Krapina rock shelter is an ancient though not very deep hollow, worn out in the basic sandstone by the now small stream of Krapinica, and subsequently filled with water-worn stones, some aluvia, and with much detritus resulting from the decomposing rock of the hollow (fig. 19). Since the formation of the latter, the Krapinica has cut its channel so that it now flows 82 feet (25 meters) below its floor level. Before the shelter was filled and during the process, it was utilized by early man of the region, at first but occasionally, later for some time perhaps continuously, and the accumulations in

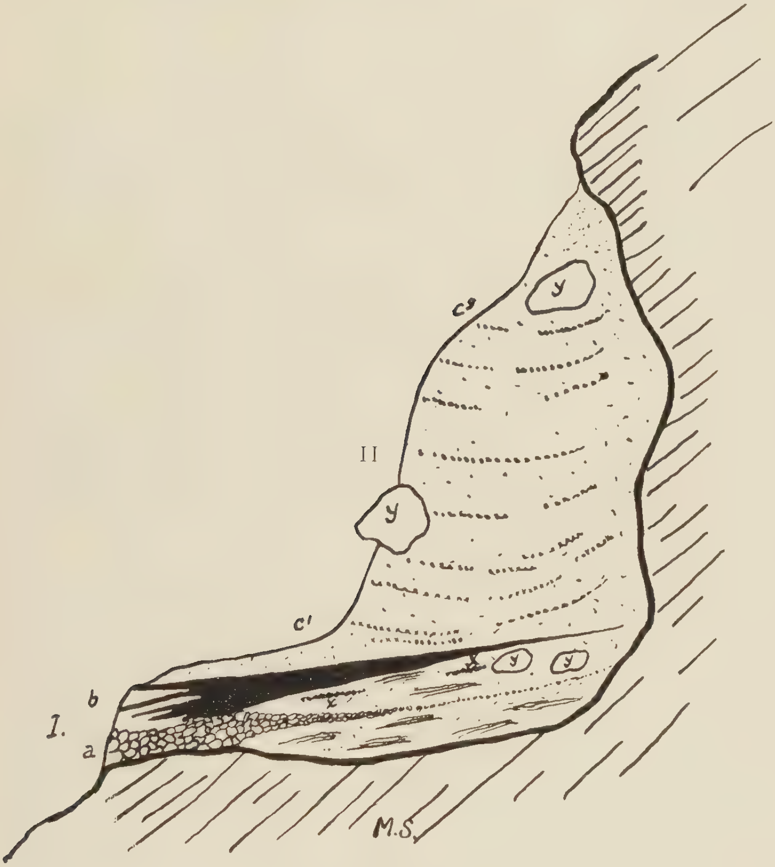


Fig. 19.—A schematic view, in transverse section, of the Krapina hollow. (After Gorjanović-Kramberger.)

M. S. = Mediterranean sandstone; *I,* the lower deposits, mostly pebbles (*a*) and alluvium (*b*); II, the upper strata, composed of disintegrated rock, and (*c1* — *c9*) cultural remains.

the cave were augmented by the remains of fireplaces and by refuse, including many primitive stone implements and rejects, as well as animal bones; and these accumulations were found to contain numerous human bones in more or less fragmentary condition.

The locality became known in 1895, after two Croatian teachers discovered in the superficial deposits of the shelter some teeth of a rhinoceros and fragments of other fossil bones. These finds were brought to the attention of the scientific men at Zagreb (the capital of Croatia, formerly "Agram"), but no thorough examination of the site was undertaken until 1899. In that year the place was visited by K. Gorjanović-Kramberger, professor of geology and paleontology of the University of Zagreb and Director of the Geological Division of the Narodni Muzej of the same city.

The deposits in the shelter and their stratification were found well exposed. They were over 26 feet in thickness from top to base. The initial work showed ashes, charcoal, burnt sand and rejects of stone industry, stone implements, and a human molar. The excavations proper, after a determination of nine distinct cultural layers, were begun from the top and carried very carefully downward. They proved from the start very fruitful,[1] giving many bones of Quaternary animals, many rejects of stone industry with some implements, a portion of a human maxilla, 80 loose teeth, and many pieces of skulls, lower jaws and other parts of the skeleton. From 1900 to 1905 the painstaking exploration of the shelter was carried on, partly by Gorjanović-Kramberger, partly by S. Osterman, and D. Galijan, his assistants, until the deposits were exhausted.

Notwithstanding the presence of numerous cultural layers and the evidently long time of use and occupation of the shelter, the whole represented apparently but one large cultural period, and this during a fairly warm interglacial time. The fauna is not that of a cold climate. It consists, aside from a few snails, birds and a turtle, of the following:

Rhinoceros merckii (frequent)
Ursus spelaeus (frequent)
Bos primigenius (frequent)
Castor fiber (fairly frequent)
Canis lupus
Ursus arctos
Felis catus
Mustela foina
Lutra vulg.
Myoxus glis
Arctomys marmota
Cricetus frument.
Equus caballus
Sus scrofa ferus
Cervus elaphus
Cervus capreolus
Cervus euryceros

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[1] These first results were reported by Gorjanović-Kramberger in "Der palaeolitische Mensch und seine Zeitgenossen aus dem Diluvium von Krapina in Kroatien." Mitteil. Anthrop. Ges. Wien, Vol. 31, pp. 164-197, 4 pls., 13 figs., 1901.

There were no traces of the mammoth or of *Rhinoceros tichorhinus*. The remains found represent either completely extinct forms, or forms that have not hitherto been known from Croatia or known only from the diluvial times. As a whole the fauna resembles closely the fauna of the diluvial station of Taubach, Germany.

ARCHEOLOGICAL REMAINS

These are described in a number of separate papers, both by Gorjanović-Kramberger and by others (see final bibliography). The total number of worked stones recovered from the Krapina shelter reaches approximately 1,000, but most of these are waste and rejects. They are mainly of flint, but occasionally also of quartz, chalcedony, and jasper. The better characterized specimens are "typically Mousterian" (Obermeier), and this applies to all layers. Gorjanović-Kramberger believed that he found also evidence of some utilization of bone.

To the writer it seems that the stone industry of Krapina should be subjected to a restudy in the light of present knowledge. It is true that there are typically Mousterian implements; but there are also blades that seem to suggest later developments.

THE HUMAN SKELETAL REMAINS

The collective human skeletal remains recovered from the Krapina shelter are more numerous than those found in any other locality of similar age, though they are very fragmentary. They represent individuals of all ages, from infancy to senility. They comprise many parts of the skull, numerous fragments of the jaws ranging to nearly complete mandibles, many teeth, and numerous pieces of other parts of the skeleton. Most of these remains have already been thoroughly studied and described by Professor Gorjanović-Kramberger in his principal memoir (1906) and in a series of other publications (see bibliography).

Through the courtesy of Professor Gorjanović-Kramberger and Dr. F. Šulje, of the Geological Division at the Narodni Muzej, in Zagreb, the writer was privileged, in June, 1912, and again in 1923, to examine the Krapina originals. This was not done with any need or hope of adding anything to Professor Gorjanović-Kramberger's thorough description of the specimens, but rather because a personal inspection and handling of the original objects in a case of such importance helps to fix in the mind, more than any description could, their extraordinary characteristics.

The human bones are, for the most part, in pieces. Notwithstanding their defective condition, however, the collection impresses the student forcibly by its scientific importance. As in the case of the Mauer jaw, the Neanderthal skeleton, and the other specimens derived from early man in Europe, the material bears the unmistakable stamp of genuineness and preciousness to anthropology, impressions which are wanting in later remains and in the case of finds that are merely urged as ancient.

The bones represent, as already mentioned, the remains of at least 20 individuals of both sexes, ranging from childhood to ripe adult age. The fragmentation of the skulls (pls. 47-55) lower jaws and some of the long bones is excessive, and of such a nature as strongly to suggest that it was caused otherwise than by accidental breaking or crushing. A number of the fragments show also the effects of burning, and one specimen, a portion of the supraorbital part of a frontal, presents some cuts. These different conditions, together with the absence of many parts of the skulls and bones, with a total lack of association of the fragments and the commingling of the human with the animal bones, led Gorjanović-Kramberger to the opinion, now generally shared, that the remains represent the leavings of occasional cannibalistic feasts and are not burials.

The Krapina bones are whitish, yellowish, or light brownish in color. They are not of great weight, but a chemical examination has shown that they are much altered in constitution, particularly in the fluorine-phosphates proportions.

The long and other bones of the skeleton show the Krapina man to have been, as compared with central European white man of today, of moderate stature and of strong, though, except for the powerful jaws, not excessive muscular development. Some individuals were very perceptibly weaker than others. As to form, particularly in the upper extremities, the bones in general are perceptibly more modern in type than those of the Neanderthal or Spy man, nevertheless they present, as well shown by Professor Gorjanović-Kramberger, numerous and important primitive features.

The fragments of the skulls show that the bones of the vault were more or less thicker than they are in the white man of today. The crania were of good size externally, but the brain cavities were probably below the present average. The vault of the skull was of good length and at the same time fairly broad, so that the cephalic index, at least in some of the individuals, was more elevated than is usual in the crania of early man. They were also characterized, as were the Neanderthal and other crania of the man from the Mousterian period, by relative lowness of the vault, and in every instance among the adults by a pronounced, complete supraorbital arch. The last-named feature, though less marked, is plainly distinguishable even in the children. Its invariable presence is a definite proof of the fact, not quite well established before, that up to a certain phase of the Quaternary period this arch was a regular characteristic of the early man of a large part of Europe.

A number of interesting features are presented by the fragments of the temporals. The mastoids are less developed than in man of today, approaching correspondingly the anthropoid form. They are rather slender and small, even in the adult male. The tympanic ring, on the other hand, is massive. The glenoid fossae are not level from side to side or even nearly so, as in man of today, but are very perceptibly slanting in such a manner that their distal end is decidedly higher than the mesial. These and other primitive features, which show the Krapina man to approach the earlier primate forms, have since become largely modified or eliminated in the human skull.

The jaws and teeth, like other cranial parts, present many marks of a less advanced stage of evolution. The lower jaws in particular are very interesting. The symphysis or fore part of these bones, while in some possessing already a faint trace of the future chin eminence, slopes invariably more or less downward and backward, thus approaching the form of the mandible in apes. The mandibles are massive and in males high. Except in this height they are akin to the lower jaws of the La Quina and La Chapelle skulls, and represent decidedly more primitive forms than the mandibulae of any man of historic times, though they are more or less nearer to the modern type than is the Mauer jaw.

Of the upper maxilla there are eight or nine imperfect specimens, the majority from young subjects. They differ in their development and conformation, but primitive characteristics are numerous. One of the best-preserved fragments, marked " E " or " 19," proceeding probably from a male adolescent and representing the part of the jaw from the right median incisor to the left second premolar, shows considerable height of the bone, a straight and prognathic alveolar process, a very spacious high palate, pronounced subnasal fossae, and broad nasal aperture.

The teeth of the Krapina man offer numerous peculiarities, most of which point to lower stages of differentiation. They are in general very perceptibly larger than those of the modern white man; their roots, especially, are longer; and there are some details of form, particularly in the crowns of the incisors and molars, which are related to anthropoid features. Notwithstanding these facts, the Krapina teeth, and particularly the canines, are on the whole fairly near those of present man.

DETAILED OBSERVATIONS ON THE CRANIAL REMAINS

The majority of the fragments are of the skulls of children and adolescents.

SKULL A, CHILD

This is one of the most valuable pieces. It comprises the larger part of the frontal with portions of both parietals. The bones are somewhat thicker than in a modern skull of similar age, the parietals reaching 4.6 mm. along the broken border. The parts preserved show that the skull was originally broad. Also the sutures are distinctly better serrated than they are in the various Neanderthal crania, and there is a persistence of the metopic suture. There is a distinct though mild indication of a complete supraorbital arch, with a slight depression above it. The forehead is, however, fairly high, well arched, but slightly sloping, and shows faintly lateral eminences, as in white children of today. There is a shallow depression posterior and parallel to the coronal suture—as is not infrequent in modern white skulls. The postorbital narrowing is but little marked in the specimen.

SKULL B, CHILD

The material comprises most of the right with an upper portion of the left parietal and a good part of the occipital bone. This piece also fails to give the impression of a narrowness of the skull; moreover, the formation of the parietal bone both superiorly and laterally approaches those in modern skulls. The occipital squama, however, shows the characteristic form of the Neanderthalers, being relatively broad from side to side and showing mild superior flattening with a fairly marked subinionic depression; the protrusion is, however, but moderate. There is an indication of occipital torus. The sutures, especially the lambdoid, are relatively simple. The bones are appreciably thicker than in the average modern skull of about this age; the thickness of the parietal, about the middle of the squama, is about 5 mm. The impressions of both the cerebrum and the cerebellum are strongly marked on the occipital bone; and the latter shows also some peculiarities of vascular impressions.

SKULL C, YOUNG ADULT

Though very defective this is an important specimen, preserving as it does the upper parts of the face, the lower portion of the frontal, the right temporal, and a large portion of the right parietal. The specimen has been reconstructed from five pieces, which however plainly belong to each other. The parts preserved show convincingly that the skull was relatively broad and not very long. The outline of the norma superior was a fairly broad and but moderately long ovoid. The cranial index was evidently at least that of sub-brachycephaly; Gorjanović-Kramberger estimated the length maximum of the skull at 17.8 cm., breadth maximum, 14.9 cm., cranial index *83.7*. This exceptional and very interesting feature, seen for the first time in early man, is also more or less perceptible on the other Krapina skull remains.

The sex of the specimen is somewhat uncertain. The supraorbital arches and other parts of the face would seem to indicate a smaller male, but the mastoids and the cranial bones are feminine. The subject was probably a female. The minimum frontal diameter (9.9 cm.) and the external biorbital (11.8 cm.) are even slightly smaller than those of the Gibraltar female, and the two specimens show similarity also in other particulars.

The supraorbital arches, though distinctly bilateral, form nevertheless a complete and rather heavy torus with a fairly marked and broad glabella depression. The torus measures in thickness, above the orbital foramen, 13.8; at the middle, 10; and at the outer end, 11-12 mm. Its ends unite with broad and stout processes of the malars, as in other Neanderthalers. The glabella is not carried as far forward as in the Gibraltar skull. The interorbital process of the frontal is stout, as is general in Neanderthal skulls, the minimum interorbital diameter measuring 2.9 cm. (Gibraltar 2.8 cm.). The inner biorbital breadth is 10.7 cm. The nasion is situated rather high but not excessively so. There is no nasion depression, the region from glabella to the free end of the nasals presenting a broad moderate concavity increasing downward. The nasal bones are broad (min. breadth of right 9, left 8.5 mm.). In its upper part the mid-nasal suture turns at an angle to the left, indicating an earlier existence at nasion of a good-sized intercalated bone.

The borders of the orbits though rather stout are fairly well defined, more as they would be in a female of this type than in a male. The planes of the orbits, both from above downwards and laterally, approach those in other Neanderthalers. The orbits are large, megaseme; yet in general they come a trace closer to those of strong modern skulls than do those of the Gibraltar or La Chapelle crania. Approximate measurements (Hrdlička): Height, r. 3.8; l. near 3.8 cm.; breadth (from dacryon) r. 4.0; l. 3.8 cm.; Index, r. near *95.0*, l. near *100*. The malars, as in other Neanderthalers, were neither protruding nor large; but as already indicated they had powerful and broad frontal processes. The zygomae are wholly wanting. The suborbital spaces ("canine fossae") are full and even slightly bulging, as in all other Neanderthalers. The nose was broad (breadth max. near 3.0 cm.); the lower parts are damaged or absent. The bones are all distinctly stronger than in modern skulls.

The vault.—The bones of the vault are not especially thick, the maximum of the parietal not exceeding 8 mm. and reaching this figure at only a few points. In this respect it differs markedly from the Gibraltar skull. Above the supraorbital ridges is a fairly broad but not deep depression, much as in the Gibraltar. The forehead above this was doubtless rather low and more or less sloping, but most of the squama is missing. The temporo-sphenoidal region is much as in modern skulls. The pterion is of the H type, rather broad. The temporal lines were not pronounced and ran at considerable distance from the sagittal suture. The parietal bone is more modern than in any of the western Neanderthal skulls. It is very perceptibly more bulging, and the eminence is situated less low and less posteriorly.

The temporal bone is of good dimensions, not low as in other Neanderthalers. The zygomae were evidently not very massive, though much stronger than they are in modern female crania. The posterior root of the zygoma forms a crest, especially in its distal half, but falls well within the range of modern variation in the same feature. The mastoid is decidedly small and slender. Behind it is seen the upper end of a broad digastric groove, reaching higher than in modern crania. The base is mostly wanting; but what is present shows some interesting conditions. The glenoid fossa is broad transversely, fairly deep, slightly less oblique than in most recent skulls, and more effectively bound posteriorly by the middle root of the zygoma and the anterior wall of the tympanic bone. And there is a considerable space, as in all the Neanderthalers, between the tympanic ridge and the mastoid (11 mm.). There was no styloid.

Endocranially, the Krapina "C" skull shows numerous and well impressed marks of brain convolutions. The frontal lobes were more beaked inferiorly—though not narrowly so—than they are in modern skulls; and the temporal lobes did not bulge out to the same degree that they do in the skulls of present day Europeans. The petrous part is relatively bulkier than in modern skulls, and the internal auditory meatus is larger and situated somewhat more superiorly. The sigmoid part of the lateral sinus is narrow but very deep; this is due to much lesser hollowing out of the adjacent portion of the occipital.

SMALLER FRAGMENTS

Frontal bones.—Present, lower portions of three frontals. All show pronounced supraorbital torus and other Neanderthaloid characters. The nasal process, seen in two of the fragments, is stout.

An important specimen is a larger part of an evidently adult male frontal (G.-K. 1901, pl. 1, fig. 1) which shows the remnant of a complete supraorbital torus, without any diminution in its stoutness from about its middle to the distal end (near middle, 12, at outer end, 12 mm.). The forehead was broad and as well arched as in many not very high skulls today. The temporal ridges are moderate. The thickness of the squama is not greater than it is in many strong skulls of today (max. 8.5 mm.). The metopic ridge is short and moderate. The frontal lobes were broad and quite as full as in many a modern brain.

In another fragment (K 15) the arches measure 13 mm. in thickness at middle, 12 mm. distally, above fracture. The orbital borders are well marked, and there is a distinct broad concavity at the glabella. The interorbital breadth is near 2.8 cm. All the bones of this skull were evidently of more moderate strength than those of some of the other specimens.

A portion of a frontal, to which are attached a large part of the right and a fragment of the left parietal, is evidently of a young subject. The bones are not thick. The frontal bone shows a fair development. The parietals indicate once more a relatively broad skullcap. There was no sagittal elevation. The sutures were somewhat simple.

Fragments of occipitals.—There are several fragments of adult occipital bones. These were in part described for Gorjanović-Kramberger by Klaatsch. The latter reported (studies on casts) that these bones show distinct differences from those of the present day, both dorsally and ventrally; and that they correspondingly approach the occipitals of the Neanderthalers. There is the same horizontal welt or torus in place of the superior nuchal line, with a more or less marked epimedian depression; while beneath the torus the squama shows a more or less distinct transverse concavity. The impressions of the sulci on the ventral surface show more or less aberrant forms from those in a majority of the skulls of today. The transverse sulci are relatively shallow. Brain impressions are in general well marked to strong.

About the best preserved piece is that described and pictured by Gorjanović-Kramberger in 1902 (Mittl. Anthr. Ges. Wien., pl. 2, figs. 3 and 4). The bone is thicker than the modern mean, and presents, though they are not very pronounced, the usual Neanderthaloid features, and shows a more prominent right lobe of the cerebrum, with but a trace of lateral sulci beneath.

Reconstruction of skull D.—From a number of fragments and with the help of photography, Professor Gorjanović-Kramberger attempted the reconstruction of one of the male adult skulls (D). The results, while necessarily of limited value, indicate nevertheless another brachycephal, with a fairly modern-like vault, with the exception of the supraorbital torus and the subinion depression on the occipital.

Numerous measurements are given of the reconstruction; but the element of uncertainty is too strong to permit of giving these a full value.

Additional fragments.—There are a number of additional pieces of skulls, all of which show points of interest and more or less primitiveness; they show also, however, other features of a transitional nature towards modern forms (p. 129). Among the most interesting are several fragments of temporal bones with the auditory meatus and the mastoids. The mastoids are everywhere but poorly developed; the posterior roots of the zygomae rise in pronounced dull ridges. The glenoid fossa in one of the pieces where it is well preserved is deep, moderately spacious, and considerably more strongly bound mesially than in modern skulls; also it slopes considerably upward and outward. The pre-mastoid space (space inferiorly between the tympanic ring or wall and the mastoid), so characteristic of the Neanderthalers, is not present in the three pieces where conditions can be well seen. But in all the fragments there is a marked digastric sulcus.

UPPER JAWS

There are six fragments of upper jaws (A-F), five of which are from individuals of less than 20 years of age, the sixth from one over 20. The fragments indicate that the Krapina maxillae were somewhat narrower than those of other Neanderthalers. In their subnasal proportions they ranged, owing probably to sex differences, from low to high. They are strong but not massive. They were evidently broad in front but not exceptionally prognathic.

One of the larger pieces from an adolescent (E) shows a broad, rather flat, slanting, high front (alv. pt. to base of spine 2.7 cm.), a rather strong though short bifid spine, lower nasal borders with subnasal fossae (double on left, a small mesial external and a larger and deeper more lateral internal) ; and a broad nose. The alveoli are strong, the teeth larger than modern. The incisors are all markedly shovel-shaped, with single to double lingual cuspules. The canine is but little higher than the incisors and not very strong; it also shows a bilateral hollowing out of the lingual surface. The bicuspids, much as in modern man though larger, show too on the lingual surface of the outer cusp a bilateral fossa. The palate was rather high and spacious.

LOWER JAWS

This series shows on the whole somewhat less fragmentation than other parts, and is of great interest. There are nine bones (A-I), ranging from that of a child of about 7 to one of an adult over 40 years of age. All the bones show the same basic primitive type, but with individual variation in all the essentials. The importance of this material calls for a somewhat detailed description. Thanks to having seen the originals, and to an excellent series of casts given me by Professor Gorjanović-Kramberger, it will be possible to give my own notes on the specimens, which however agree almost entirely with those of that distinguished author. The measurements are essentially his, however.

Lower jaw A.—Fragment of a juvenile mandible with middle incisors in eruption (child of about seven years). Was evidently somewhat prognathic (symphyseal regions receding). Thickness at symphysis, 11.3 mm.

Lower jaw B.—A portion of the mandible of a child after a full eruption of the middle incisors, extending from the right canine to the left M 1. (Child of eight years or a little over.) Prognathic.

Lower jaw C.—Present, the right half of the body (up to the left canine) and the right ramus. Belonged to an adolescent of about 13 years of age. Is of a relatively moderate size, with but moderate height of the body, but the body is stout and the teeth are large. The symphyseal portion is flat and receding. The ramus approaches vertical, was of good but not excessive height and breadth, and with the sigmoid notch well developed. The outline of the angle is rounded, nevertheless the angle is fairly distinct and the region approaches closely to that of modern jaws. The mylohyoid ridges are relatively strong. A marked crest extends from the mylohyoid ridge to the mandibular foramen. The dental arch diverged very perceptibly from before backwards.

Measurements:	cm.
Height at symphysis, approx	2.9
Height at M2	2.0
Thickness at symphysis	1.34
Thickness at M2	1.76
Breadth of ramus, min	2.95

Lower jaw D.—A fragment of the anterior part of the left body, from the symphysis to the alveolus, with five teeth; estimated to have belonged to an adolescent of 16-18 years. Female. The bone is stout, though within the range of variation of strongest modern jaws. The body was low, as usual in a female. The symphyseal portion, flattened and slightly receding, shows a moderate eminence of a chin. The inferior border forms a well marked flat surface, with long facet for the attachment of the digastric muscle. The lingual surface of the bone shows a low, dull transverse epimedian ridge, and also a low vertical central ridge, with bilateral shallow depressions both above and below. The teeth in size are about as those in strong lower jaws of today. The canine and the lateral incisor were moderately shovel-shaped; the anterior bicuspid shows on its labial cusp remnants of the same condition. In both shape and size the canine resembles closely the incisor, though it is broader and its body is thicker. The first molar is relatively somewhat long and narrow (ant.-post. diam. 12; transv. diam. 10.5 mm.).

Measurements: (G.-K.)	cm.
Height at symphysis, estimated	3.3
Height at I2	3.05
Height at M1	2.9
Thickness at symphysis	1.36
Thickness at M1	1.45

Lower jaw E.—The larger portion of the left body, probably of a female less than 20 years old. The bone is stout and the teeth are large; yet the specimen probably belonged to a female, the body being too low for a male. The symphysis is flat and slopes backward in a straight line; it has no appreciable evidence of a chin. The canine is stout and dull-pointed, otherwise much like the neighboring incisor. The lower border is markedly flattened for the digastric attachments. Lingually, anteriorly the bone resembles the preceding specimen (D), though the ridges and depressions are less defined. The mylohyoid ridge is unusually pronounced, the fossa for the submaxillary gland deep and broad.

Measurements:	cm.
Height at symphysis	3.5
Height at M2	2.5
Thickness at symphysis	1.35
Thickness at M2	1.65

Lower jaw F.—A portion of the left body, from I1 to M1, of an adult, probably female.[1]

The bone is fairly stout. The symphyseal region was probably flat, or slightly receding, with a minute indication of a chin eminence. The incisor part of the jaw is square, connecting with the body at a dull angle formed by the canine. Similar squareness is also found, though rarely, in modern jaws. In details the bone resembles fragment E.

Measurements:	cm.
Height, to the left of the symphysis, approx	3.1
Height at P2	2.74
Thickness at symphysis	1.45
Thickness at mental foramen	1.55

Lower jaw G.—The right and a portion of the left body of an adult jaw, female, with the three right molars. A stout but low bone, with a straight receding symphyseal line, with a merest trace of a chin swelling. The dental arch was **U**-shaped, opening somewhat from P2 backward. The teeth are about as large as in strong modern jaws, but give an impression of moderate relative narrowness (linguolabially). The M3 is slightly smaller (both shorter and narrower) than either M1 or M2. The lower border presents a marked broad flattening, which extends to below P2, for the attachment of the digastrics. There are on the right three (instead of the usual one) mental foramina, all located beneath the M1. Lingually the frontal part of the jaw shows traces of the transverse epimedian dull ridge and also of the vertical symphyseal one, with a shallow depression on each side above and another larger beneath—the same formation as seen in the other jaws where these parts are preserved. The submaxillary gland fossa is V shaped, deep, spacious.

Measurements:	cm.
Height at symphysis	3.15
Height at M2	2.8
Thickness at symphysis	1.5
Thickness at M2	1.45

Lower jaw H.—Powerful adult male jaw, with very typical and pronounced Krapina symphysis: straight, flat, receding and with a very small chin eminence; with a high, strong body; with a nearly U-shaped dental arch, broad in front and moderately diverging backwards; and with all 16 teeth, moderately worn, of about the size of those in very strong modern mandibles. The third molars are perceptibly smaller than the first and second.

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[1] The sex identifications are all by the writer.

The lower border of the jaw is broadly and widely flattened for the marked insertions of the digastrics; it is a regular 15-16 mm. broad surface, extending laterally as far as the molar region. Anteriorly, in the middle, the border of this surface bends downward with a dull symphyseal protrusion, which gives to the inferior outline of the jaw a cupid's-bow effect, recalling the similar but more pronounced feature in the Mauer mandible. The lingual surface of the bone anteriorly shows only the faint epimedian dull ridge, with bilateral shallow depressions above and below, like that seen in the other Krapina jaws. The genial tubercles, as in the other jaws, are low and small, although not beyond the range of modern variation. The mental foramen at left is double, at right large single; both are located beneath the posterior parts of the first molars.

Measurements:	cm.
Height at symphysis	4.0
Height at M2[1]	3.35
Thickness at symphysis	1.55
Thickness at M2	1.5

Lower jaw J.—This is the best preserved of the Krapina mandibles, being damaged only at the posterior part of the left ramus. It is at the same time the largest of the jaws. It belonged to an adult male of probably somewhat advancing years. The specimen is marked by its size, breadth, and strength. Like the other Krapina jaws it has a flat, receding symphyseal portion without a chin. The medium broad and high rami are surmounted by strong coronoid processes, a well marked sigmoid notch, and stout, broad, flat, not entirely healthy condyles, especially on the right side. The surface of the condyles has been affected through arthritis.

The left ramus, well preserved, measures 7.9 cm. in height (Hrdlička's method), 3.8 in minimum breath. The mandibular angle is close to 118°. The border of the angle is rounded, but not more than in modern skulls; it lacks, as in the other Krapina jaws, the simian aspect that it shows in the La Quina and La Chapelle mandibles. The inferior border is irregularly flattened for the large insertions of the digastrics. The outline of the lower border, as in jaw H, is very distinctly cupid's-bow shaped, owing to its arching and a marked lower symphyseal protuberance.

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[1] All these heights are taken dorsally; lingually the height is often somewhat greater.

The lingual surface, anteriorly, shows similar conditions as the other lower Krapina jaws. The mylohyoid ridge is very strong, and bifurcates as in the other Krapina jaws where it may be observed, one branch leading upwards, along the coronoid process, the other backwards to the mandibular foramen and the base of the condyle. In front of the vertical ridge is a large marked fossa, below the bifurcation is a spacious pronounced hollow for the internal pterygoid muscle. The mandibular foramina are situated high, as also in the other Krapina specimens, and are large. The mental foramina (single on the right, double on left), are located below the rear part of Ms 1. The dental arch is nearly **U**-shaped, with the branches moderately diverging. There are still present 13 teeth. The teeth are large, megadont, and this effect is further increased by the tartar concretions. The M 3 is smaller than M 2. There is a relatively wide space between the last molars and the anterior coronoid border.

In all these characters, except in the coronoid prolongation of the mylohyoid ridge, the jaws differ more or less from modern ones, but approach closely those of La Chapelle and other early mandibulae.

The condyles (altered through arthritis) measured r. 29.5, l. 28.8 mm. transversely; and r. 16.5, l. 15 mm. antero-posteriorly.

Additional Measurements:	cm.	
Height at symphysis	4.23	
Height at M2	3.22	
Thickness at symphysis	1.5	
Thickness at M2	?	
Breadth of the ramus, min	3.7	
Bicondylar diam.	14.8	(cast)
Bigonial diam. approx	11.2	(cast)

Lower jaw No. 16.—This is not described in Gorjanović-Kramberger's Memoir. The specimen consists of the right ramus with a portion of the right body enclosing a damaged third molar. Evidently part of the jaw of an adult female.

At first sight the specimen looks much like a portion of a modern lower jaw. The ascending ramus is 6.9 cm. high (from the mid-point connecting the uppermost parts of the condyle and the coronoid process to a point on the inferior border of the bone corresponding to the mid-line of the ramus) by 3.6 cm. broad. The mandibular angle is approximately 118°. The height of the ramus at the third molar is

2.5 cm.; thickness 1.65. Transverse diameter of the condyle, 2.25; antero-posterior diameter, 1.3; maximum depth of notch, 1.15 cm.[1]

The mandibular angle is rounded but not more so than in some modern specimens. On the lingual side, however, the piece shows the typical characteristics of the Krapina and other early jaws, viz., the high mylohyoid ridge, bifurcating into marked vertical (coronoid) and transverse ridges, the latter reaching the mandibular foramen and passing beyond it to end on the posterior border of the ramus; while beneath the mylohyoid ridge and its transverse prolongation there is a marked hollow for the internal pterygoid.

Summary.—The highly interesting assemblage of the lower jaws of Krapina permits of certain generalizations. The bones present many marks of primitiveness. In these they resemble more or less the jaws of the western Neanderthalers; in others they show features that connect with those of recent man.

About the most distinguishing features of the Krapina jaws are the flattening, straightness, and recession of the incisor segment of the bone. In some of these jaws (H, E) these features are more striking than in any other early jaws; though the same characters in a somewhat milder degree are shown also by the La Naulette, Šipka, and even Spy No. 1 mandibles.

Other primitive characters are the size and stoutness of the bones; the megadont teeth; the multiplicity, size and backward location of the mental foramina; the flat inferior border; the ridges and depressions on the anterior portion of the lingual surface; the pronounced mylohyoid ridge with large submaxillary-gland fossa; the presence of a marked precoronoid fossa (between the anterior border of the coronoid and the internal coronoid ridge or root); the presence of a condyloid ridge or root (which after uniting with the coronoid forms a very strong mylohyoid ridge); and the large, much hollowed out depression for the internal pterygoid. In jaw J, there are added to this the enormous condyles. Other primitive features are the cupid's-bow arching, in at least two of the jaws (H and J), of the inferior frontal portion of the bone; and the presence in J of a relatively wide space between M 3 and the anterior coronoid border.

Features in which the Krapina jaws are more or less superior to some of the early jaws, especially the La Chapelle and Mauer, are: total absence of inferior frontal shelf; attenuation of the old and approach to more recent conditions on the frontal part of the lingual surface of the jaw; and a closer approach to modern conditions in the height and breadth of the ramus, in the mandibular angle and its border, in the sigmoid notch, and in the condyle (in some of the specimens).

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[1] All these measurements taken on a cast kindly furnished to the writer by Professor Gorjanović-Kramberger.

THE KRAPINA TEETH

In addition to the teeth contained in the Krapina maxillae and lower jaws, nearly 200 isolated teeth of all ages are included in the collection. Thirty of this number are milk teeth. Gorjanović-Kramberger devotes, in his principal memoir (1906), a large chapter to a detailed description and measurements of the teeth, pointing out many interesting details, both as to the crowns and as to the roots. From this and the writer's own observations the following generalizations are possible:

The upper incisors are generally shovel-shaped, in addition to which they show from one to three lingual small cusps. The canines are of about modern macrodont size and form, but slightly higher than the incisors, and with distinct traces of a lingual shovel-shaped hollow, divided into two lateral fossae by a stout vertical ridge. The upper premolars approximate the canines with the labial canine cusp reduced and the lingual strongly developed. They, too, show the vertical median ridge on the lingual surface of the outer cusp, with a bilateral depression. The molars (23 upper, 26 lower) are all good-sized to large, and show numerous interesting details, both as to the conformation of the crowns and that of the roots. Some of these details are of primitive nature, though on the whole the teeth approach closely to those of present man. The Krapina third molars, while all large and well developed, show nevertheless as a rule a tendency toward slightly smaller dimensions than those of both the first and the second molars; while the second molars are often a trace larger or at least broader than the first. The roots of all the teeth show considerable length as well as strength; and there is observable an inclination to greater multiplicity than in the teeth of the modern Europeans.

Professor Gorjanovič-Kramberger's measurements of the teeth are given on the following page.[1]

SKELETAL REMAINS OTHER THAN SKULLS

The trunk.—Present, numerous more or less damaged vertebrae and parts of ribs. The spines represented by the vertebrae appear to have been somewhat weaker and the individual vertebrae smaller than

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[1] For the writer's measurements of the lower molars, see section on teeth.

MEASUREMENTS OF KRAPINA TEETH (G.-K.)

Tooth	The Crown: Length (antero-posteriorly)	The Crown: Breadth (linguo-labially)	Height	Total Tooth Length
Milk Teeth:	*mm.*	*mm.*	*mm.*	*mm.*
Upper Jaw				
I1	8.3 – 8.55	6.4 –11.2	ca. 6.2 – 6.5	19.4 –19.55
I2	6.55– 6.7	6.2	6.5 – 6.8	19.15–19.6
C	7.6 – 8.4	6.4 – 7.3	6.6 – 8.0	19.9 –21.5
M1	9.0 –10.0	7.6 – 9.0	6.0	....
M2	8.75–10.6	10.0 –11.3	6.0 – 6.9	ca. 9.0 –17.0
Lower Jaw				
I1	5.9	4.8	5.0	19.0
I2	5.6	4.5	....	18.0
M1	9.6	8.0	7.0	18.0
M2	10.0 –11.2	8.7 –10.1	5.4 – 6.6	14.0 –16.55
Permanent Teeth:				
Upper Jaw				
I1	9.9 –10.4	8.0 – 8.9	10.6 –12.8	.....
I2	8.3	9.0	11.35	.....
(I2 juv.)	[8.2	6.0	8.2]	.....
C1	9.0	9.55–10.55	12.6	.....
P	8.0 – 8.5	10.5 –11.5	10.0 – 9.45	.....
M1	10.0	11.6	7.2 – 6.5	.....
M2	11.5	12.3	7.35– 8.0	.....
M3	12.2	12.0	6.0 – 7.9	.....
Lower Jaw				
C1	7.55– 8.2	8.2 –10.0	12.3 –14.0	.....
l. P1	8.1	8.5	10.2	.....
l. P2	8.35	9.55	7.7	.....
M1 l.	13.4	12.4	7.5 – 9.0	.....
M1 r.	12.4	10.8	6.5 – 7.5	.....
M2	10.7 –12.1	10.3 –11.0	6.2 – 8.0	.....
Permanent Teeth:				
Upper Jaw				
I1	10.0 –11.0	9.4	13.1	28.0 –32.0
I2	7.55– 8.9	8.6 – 9.5	6.0 –11.0	27.0 –30.9
C	9.2 –10.5	10.0 –11.3	10.7 + x	32.7 –36.0
P	8.0 – 8.25	11.35–11.4	8.0 –10.1	23.0 –28.25
M1	11.0 –13.3	12.5 –13.35	....	20.0 –24.6
M2	10.0 –12.0	11.2 –14.0	....	21.0 –25.0
M3	10.0 –10.2	12.5	....	24.0
Lower Jaw				
I1	6.2	8.1	10.2	26.0
I2	7.5	8.2	10.0	26.5
C	8.0 – 8.4	c. 10.0	13.4	35.2
P1	7.8 – 8.3	9.0 –10.0	8.6 – 9.0	23.7 –27.0
P2	8.5	9.9	8.0	25.9
M1	11.2 –13.8	10.5 –12.4	6.5 – 9.4	19.3 –26.4
M2	11.4 –12.5	10.6 –11.4	6.8 – 7.5	19.9 –21.0
M3	11.1 –13.6	10.0 –11.0	....	21.0 –24.5

those of the present Europeans; but it is quite probable that the bones present are predominantly those of females. The ribs appear to have been more open, and are somewhat stouter or rounder in cross section than those of present Europeans. A number of the vertebrae show signs of arthritis (of probably senile origin).

More in detail, the cervical vertebrae, as far as preserved, are not very robust and show a marked shortening of the anterior portions of their bodies, which would seem to indicate that the neck was somewhat arched backward; but the material is not ample enough for valid generalizations. The lesser curvature of the ribs indicates deeper chests; while the rounder form of the rib bodies is a primitive condition.

The clavicles.—Present, 11 right and 10 left bones, from individuals of different ages. The adult bones are in general slender, none of them reaching the strength of those of the Neanderthal or Spy specimens. They show a marked torsion in their distal half, more marked than in modern clavicles. There are marked differences in strength between the right and the left bones, the left being considerably weaker.

In form most of the Krapina clavicles are flattened, but in one of the well preserved adult bones the shaft is distinctly stouter than in the others. The latter clavicle deserves a special notice. It is evidently a female bone, 14.9 cm. long, with a marked ∽ flexion. It is of about medium female strength, though relatively to its considerable length (for a female) it appears slender. The most peculiar features of the bone are at its distal extremity, which is remarkably thick but narrow, looking but little like the average flattened extremity of the modern clavicle. The end, very stubby, looks as if the epiphyseal cap may be missing. Inferiorly there is a very pronounced and long trapezoid ridge reaching to the conoid tubercle, which reversely is but slightly developed. The other clavicles, all more or less damaged, show varied forms.

The scapulae.—Present, 12 fragments. In general the bones were evidently much like those of modern man, nevertheless there are some interesting differences in detail. Regrettably the small number of the specimens and their defective state permits of but little valid generalization. Professor Gorjanović-Kramberger has recently (1927) published a very detailed study of these bones, with many comparisons.

The humeri.—Fragments of eleven right and eight left bones; three of the nineteen specimens belong to children. No head of the bone has been found, what remains being usually the lower ends with a portion of the shaft. The longest piece comprises the lower two thirds of the bone. It is plainly the left bone of a nearly-adult female. The shaft is of about medium female strength, and the whole bone is much like some modern humeri. The shaft approaches type 1 (prismatic) in shape at the middle, becoming regularly prismatic in the lower third. The deltoid eminence is very moderate, the semi-circular canal very shallow. The lower extremity shows a pronounced development of the mesial condyle, one of the few features in which the bone differs from the modern. The condyle is not merely prominent but also stout, with a large facet for the teres and flexor muscles. There is a very large perforation of the septum; and the olecranon fossa is distinctly more spacious and deep than it is in modern humeri. The articular facets fall well within the range of their variation in modern bones.

Dimensions at middle, 2.0 x 1.5 cm.; index, *75.0*.

The lower third of another left humerus is also fairly well preserved. This may have been the humerus of another female, though this is not certain. The shaft is slightly broader but a trace less high than that of the previous bone; it is equally prismatic (lower third). The bone comes from a fully adult subject. There is no perforation of the septum. The mesial condyle is again markedly developed, even slightly more so than in the first bone, and is equally stout. The olecranon fossa is large and deep. The articular surfaces resemble fairly those in modern bones. The maximum breadth of the lowest end is 6.7 cm., which is rather large, but this is due in an important measure to the overdevelopment of the mesial condyle. Without this condyle the lower end looks feminine.

A third specimen, also the lower third, is stronger than the two previous, is apparently masculine, and differs from both the preceding in the absence of the highly developed mesial condyle, the part being developed much as it is in modern bones. The olecranon fossa is once more very large and deep, the coronoid shallow. There is a small perforation of the septum.

The radii.—Present, fragments. The best of these is evidently an adult bone, of originally fair length, of moderate strength, and of but moderate curvature, differing in the latter respect from the usually much arched western Neanderthal radii. There are in addition parts of seven right and three left bones. All are slender, some at least being plainly feminine. In form they are close to those of recent man, except in the uppermost portion (tuberosity, neck and head), where some differences are observable. The tuberosity appears, in some specimens at least, to be located somewhat more inward and backward than in recent man, and the neck in the Krapina bones appears to be somewhat longer and more slender than it is in present Europeans.

The ulnae.—Present, 11 fragments. These bones, too, are relatively slender. They are not very different from modern bones of similar strength except in the upper articular facet for the radius, which is of a somewhat different shape (especially narrower from the front backward) ; in the basal portion of the sigmoid cavity, which is shallower than in modern bones; in the muscular impressions about the head which are more pronounced than in modern bones of similar strength; and in the top part of the olecranon process which is decidedly larger in the Krapina as in other Neanderthal ulnae, especially in its antero-posterior direction, than in modern man. One of the bones shows advanced arthritis.

Bones of the hands.—Those that remain are in general much like those of present man, though differing in some details in which the Krapina bones show generally more primitiveness.

The pelves.—The nine pieces present resemble closely remains of later man, but are too defective for any important conclusions. The largest remaining piece, comprising most of the left ischium with a large portion of the ilium, is from a male adult and shows about medium masculine proportions.

The femora.—Present, numerous fragments, clearly intentionally broken for the marrow; among them were two left upper ends with a portion of the shaft, one male, one female. Both of the large pieces approach in general similar parts of the femora of today; though there are also some differences. Neither of the bones shows the stocky head and neck of the Neanderthal and the Spy femora, being much more comparable to the bones of today; nor do any of the fragments indicate a marked forward arching of the whole shaft, such as is present in the western Neanderthalers—in fact, what is preserved would indicate that the shaft was fairly straight.

The male bone shows very little that could not be duplicated in a modern strong male femur. It has a pronounced third trochanter in the form of a ridge reaching from the level of the lower part of the trochanter minor to and over the lower fourth of the trochanter major; this, too, can be found in modern bones. The subtrochanteric flattening is moderate, though better marked than in the majority of the Neanderthal femora (diam. max., 3.7; diam. min., 2.6 cm.; Index, *70.3*). The walls of the bone are very thick, especially antero-mesially (close to 10 mm.) ; the medullary canal on the other hand is very moderate. The digital fossa, the posterior slope of the neck, the trochanter minor, are all in size and situation close to some at least of those in modern femora of similar proportions; though the digital fossa is somewhat more spacious than in most modern femora. The set of large vascular foramina anterior to the intertrochanteric ridge is much the same, even to some details, as in modern man.

The female bone also resembles closely that of a modern female of similar size, but there are a few differences. The mesial part of the upper portion of the great trochanter in the Krapina bone shows a distinct and large semilunar surface for the attachment of the obturator. The digital fossa is somewhat more spacious, though not deeper, than in modern bones. The basal part of the posterior surface of the neck including the intertrochanteric line is widely and fairly deeply concave, which is less marked in the preceding male Krapina femur, and still less in modern bones. There is again a marked and long ridge in place of the third trochanter, which reaches in this bone about 3 cm. below the level of the trochanter minor, where it unites with the less marked pectineal ridge proceeding from the latter. The anterior surface of this bone is remarkably flat, the subtrochanteric flattening distinct though not excessive (diam. max., 3.0; diam. min. 2.1 cm.; Index *70.0*). The walls of the bone again are stout (anteriorly and posteriorly), the medullary canal small.

The tibiae.—Present, only small fragments of the shaft, with two of the lower extremity; these show dull borders, perhaps a slightly greater arching forward than in modern bones, with lower articular facet much like that of the Spy tibiae and correspondingly differing from that of present man.

The fibulae.—Present, pieces of eight right and six left bones, without upper ends and only one with the lower extremity. The best piece shows evidently a female right bone, of about medium female strength and of fair length. The shaft, flattened, shows five distinct borders and surfaces, without any fluting except in the upper third of the external surface. The shape and other characteristics of the bone can be duplicated in modern female fibulae.

The patellae.—Present, 15 specimens of different ages. In size and shape much like those of man of today.

Measurements given by Professor Gorjanović-Kramberger:

Length	42.3—44.4 mm.
Breadth	46.6—49.0 mm.
Thickness	23.2—24.0 mm.

A male patella, of which the writer has obtained a cast from Professor Gorjanović-Kramberger, has evidently not been included in the above. It measures (cast):

Length	46.0 mm.
Breadth	50.0 mm.
Thickness	24.5 mm.

The calcaneus.—Present, a portion of one adult bone only. The articular facets show a primitive condition.

The astragali.—Present, two whole left bones and seven fragments, all showing similar characteristics. As in the other Neanderthal astragali, these bones are marked by their relative shortness, and especially by the shortness of the neck; by a marked depression superiorly between the head and the tibial facet; by a relatively large development of the sustentaculum; and by some peculiarities of the articular facets.

Bones of the feet.—Present, numerous isolated specimens representing different parts of the foot. They all come, in general, close to those of the modern man; yet they differ here and there in particulars which as a rule are of more primitive nature. Gorjanović-Kramberger gives very detailed descriptions of all these parts with measurements. Although the tarsal bones are in some respects especially primitive, nevertheless a transition to the forms of recent man is everywhere evident.[1]

CONCLUDING REMARKS ABOUT THE KRAPINA SKULLS AND SKELETONS

Notwithstanding their defective condition, the numerous fragments of the Krapina skulls show clearly that the crania they represent belonged in general to the Neanderthal phase of early man. Many of the distinguishing characteristics of the latter are here repeated—the supraorbital torus, the sloping forehead, the peculiar occipital, the planes of the orbits, the stout nasal and malar processes, the effects of powerful masticatory apparatus, a relatively lower position of the zygomatic arches, small mastoids, and other features.

All these features present, however, a considerable variation, and that of a rather progressive tendency. Thus some of the foreheads approach closely those of some recent men; even the vault of these

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[1] Gorjanović-Kramberger, K., Der diluviale Mensch von Krapina in Kroatien. Wiesbaden, 1906. "Bei allen den erwähnten Abweichungen der einzelnen Elemente der unteren Gliedmassen sehen wir dennoch schon den Typus des rezenten Menschen ausgeprägt, oder mit anderen Worten, wir finden das allmähliche Übergehen jener primitiveren Charaktere in die nun bestehenden des Europäers deutlich ausgesprochen."

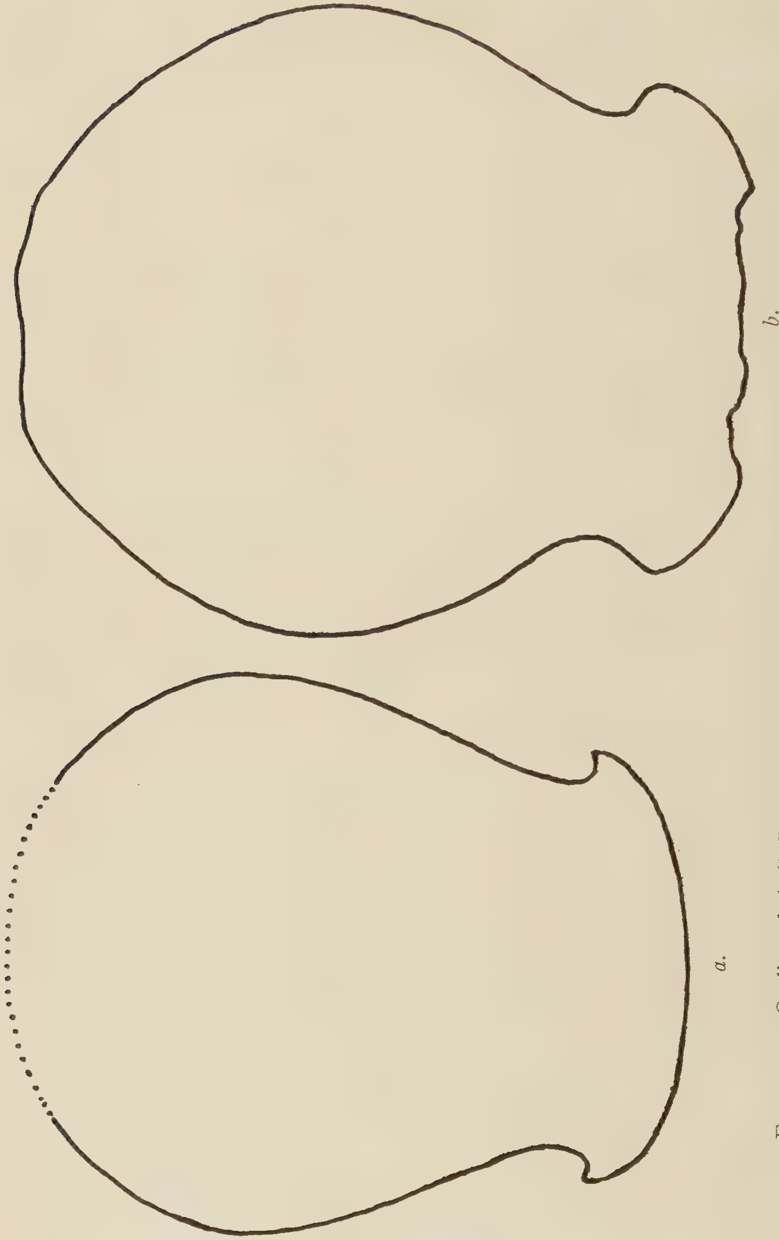
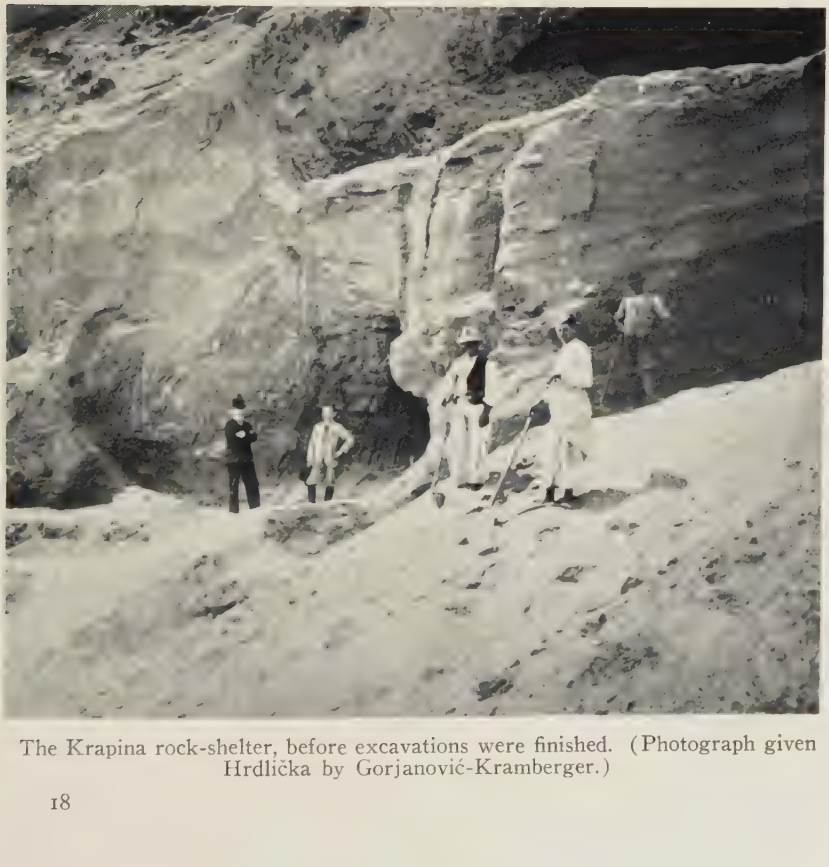
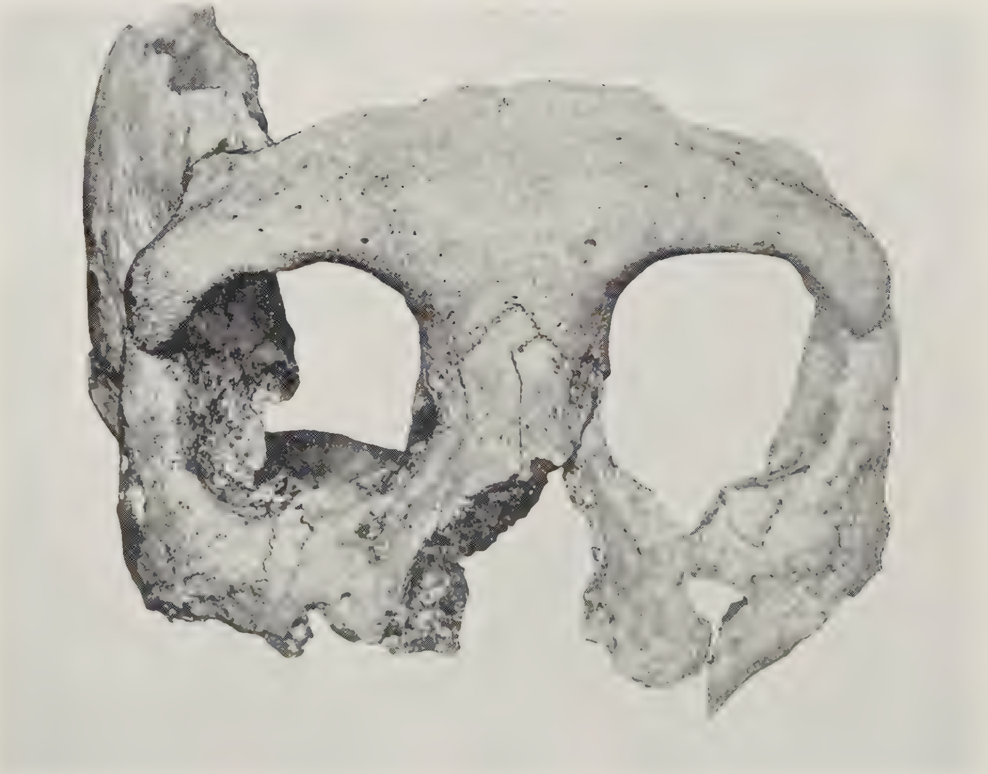


FIG. 20.—*a*, Outline of skull C as seen from above; *b*, outline of skull D as seen from above. (After Gorjanović-Kramberger.)

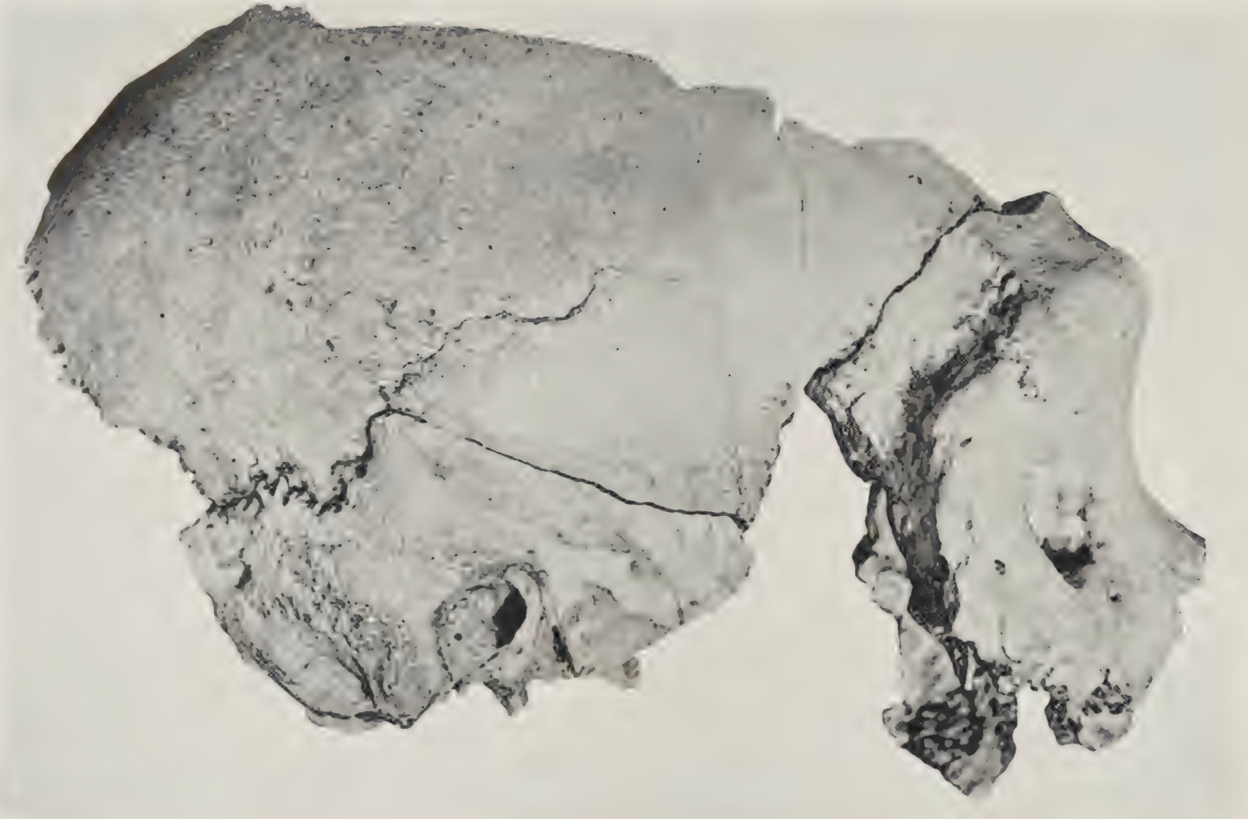
1. General view of the Krapinica valley.



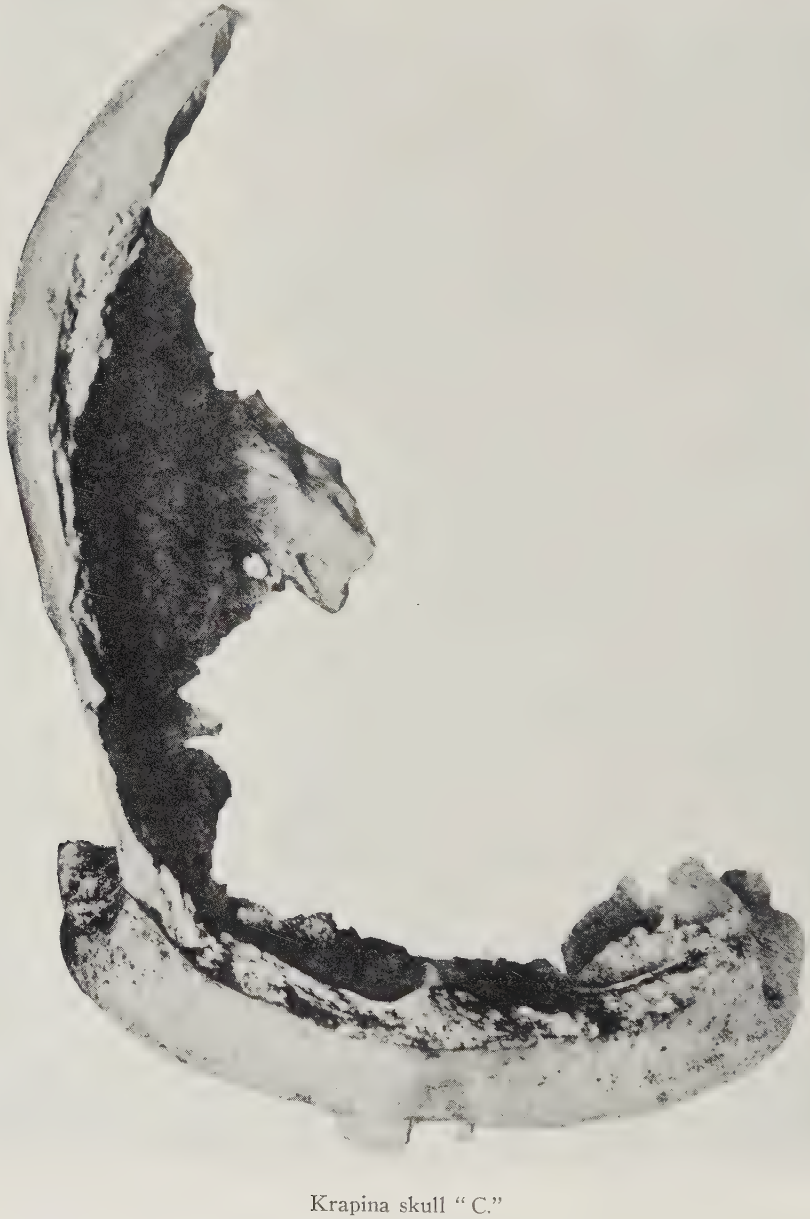
The Krapina rock-shelter, before excavations were finished. (Photograph given Hrdlička by Gorjanović-Kramberger.)



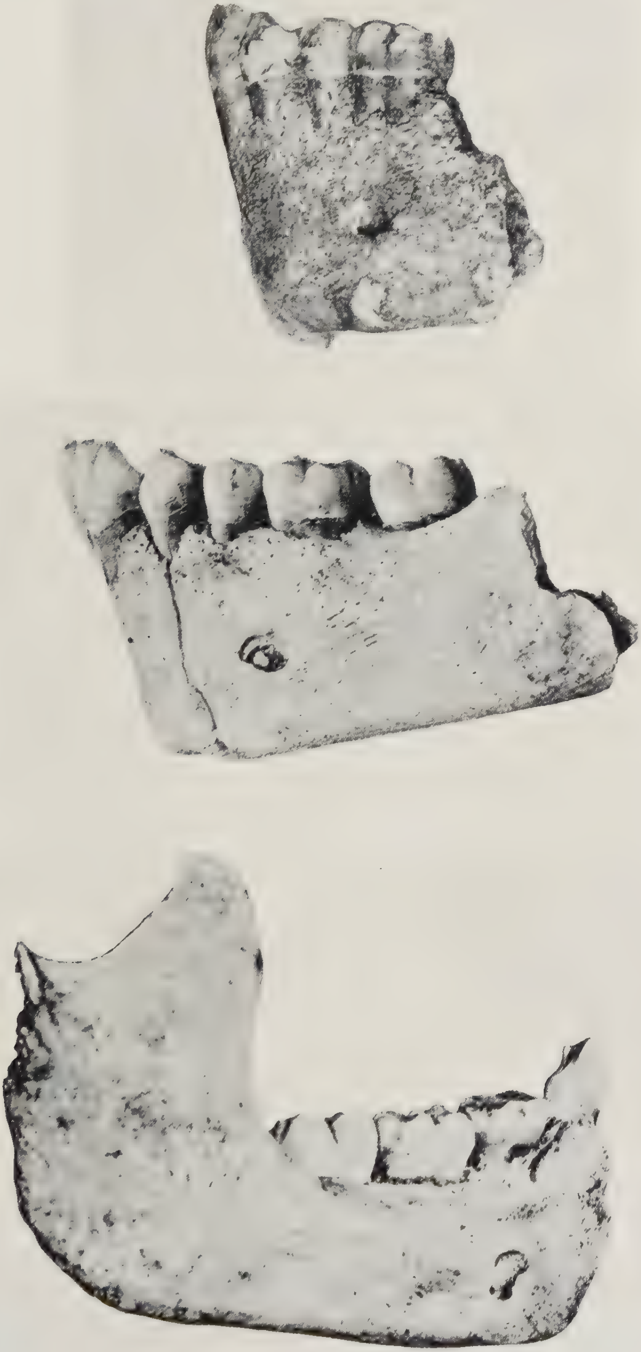
Krapina skull "C." (After Gorjanović-Kramberger.)



Krapina skull "C," side view. (After Gorjanović-Kramberger.)



Krapina skull "C."



Krapina jaws, "D" (upper), "E" (middle), and "C" (lower).
(After Gorjanović-Kramberger.)

Fig 1.

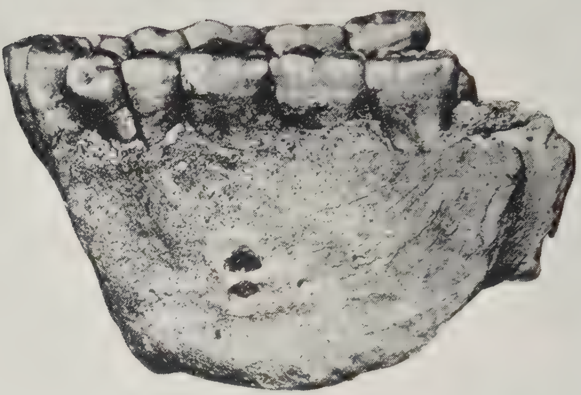
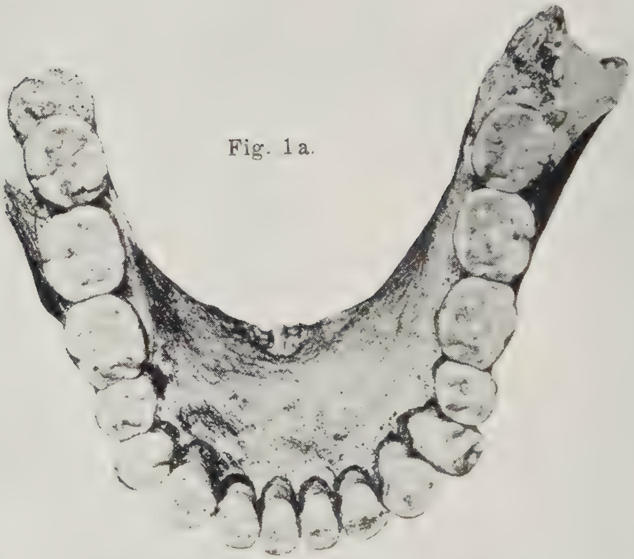
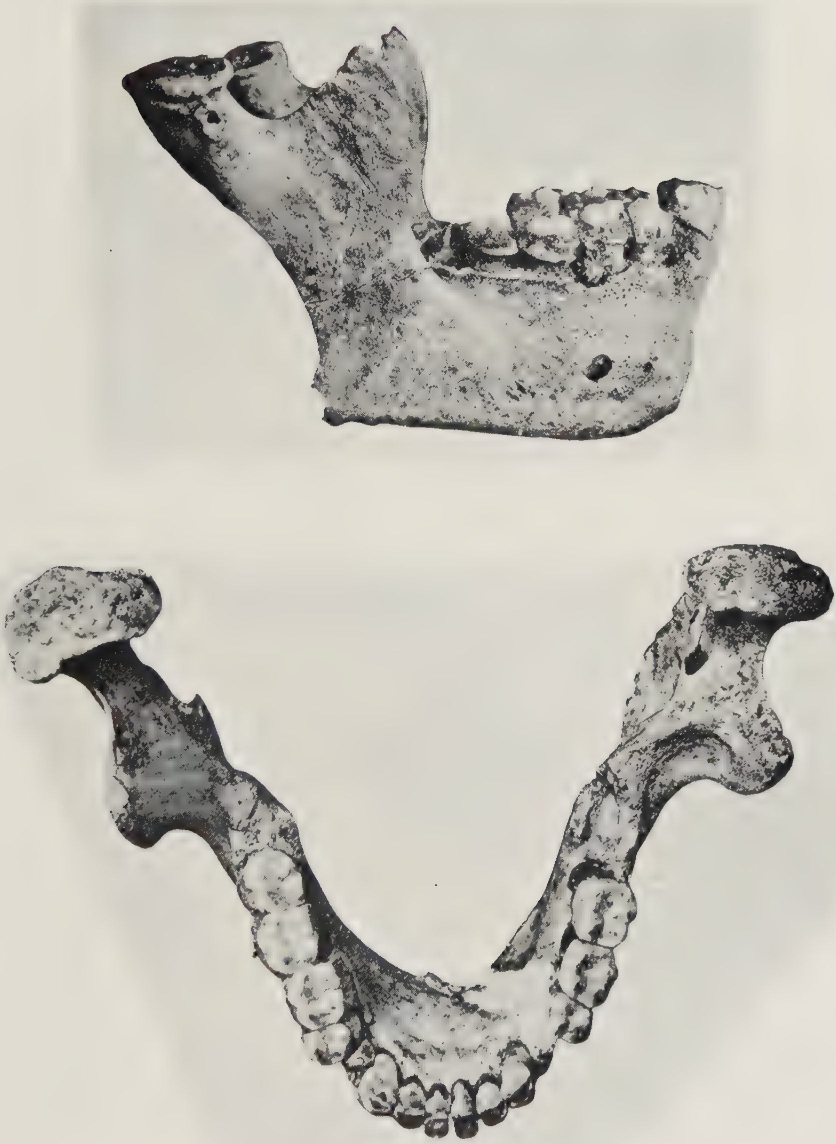


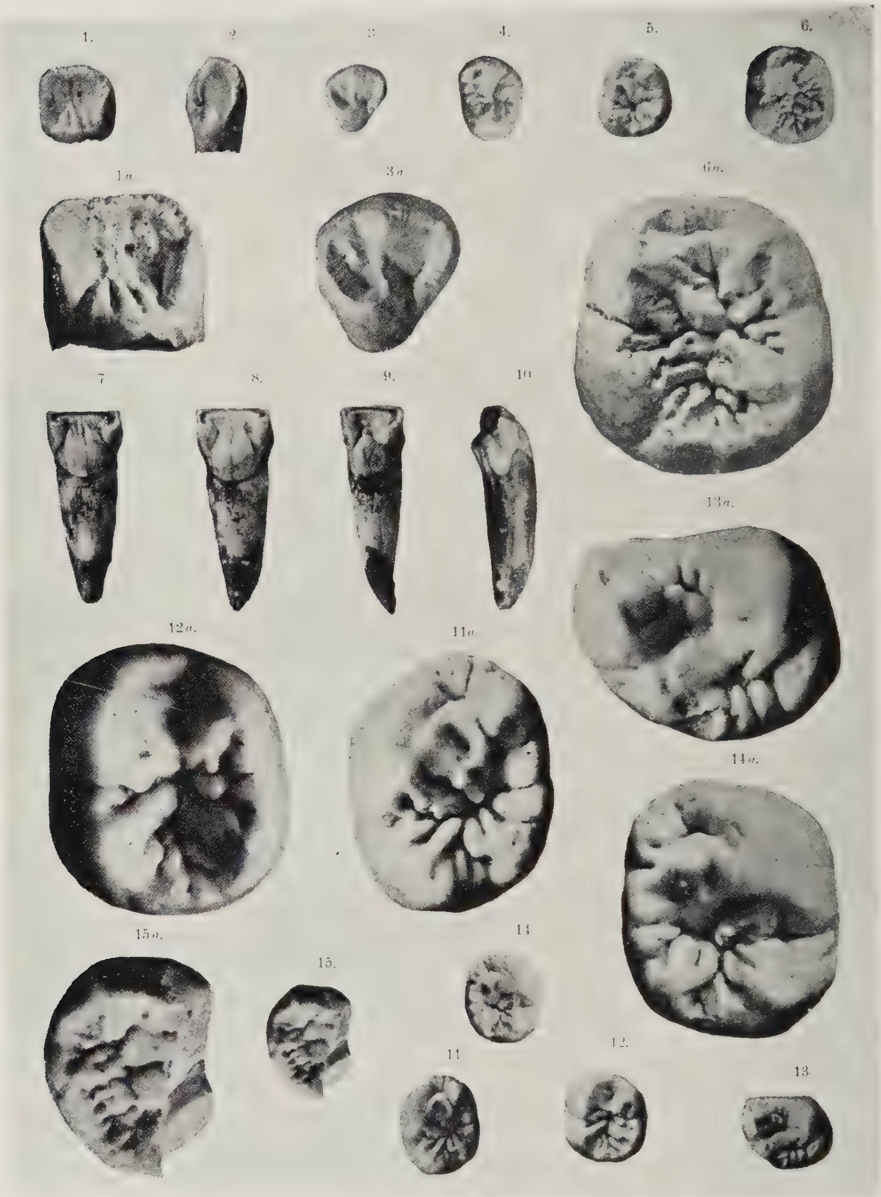
Fig. 1a.



Krapina jaw "H." (After Gorjanović-Kramberger.)



Krapina jaw "D." (After Gorjanović-Kramberger.)



A number of the Krapina teeth, more or less enlarged.

1, permanent median upper incisor from a small child; 1a, the same, greater enlargement; 2, permanent upper canine, root not as yet fully developed; 3, permanent anterior lower premolar, right side; 3a, the same in greater enlargement; 4, permanent second(?) upper molar; 5, permanent lower left second molar; 6, permanent left lower first molar; 6a, the same much enlarged; 7, permanent upper median incisor, edge worn off; 8, ditto; 9, lateral upper permanent incisor; 10, ditto; 11, a third permanent molar; 11a, the same in greater enlargement; 12, the left lower permanent second molar; 12a, the same much more enlarged; 13, the right permanent second molar; 13a, the same in greater enlargement; 14, a third permanent molar; 14a, the same in greater enlargement; 15, a permanent third molar; 15a, the same. (From Gorjanović-Kramberger, Mitth. Anthrop. Ges. Wien, Vol. 31.)

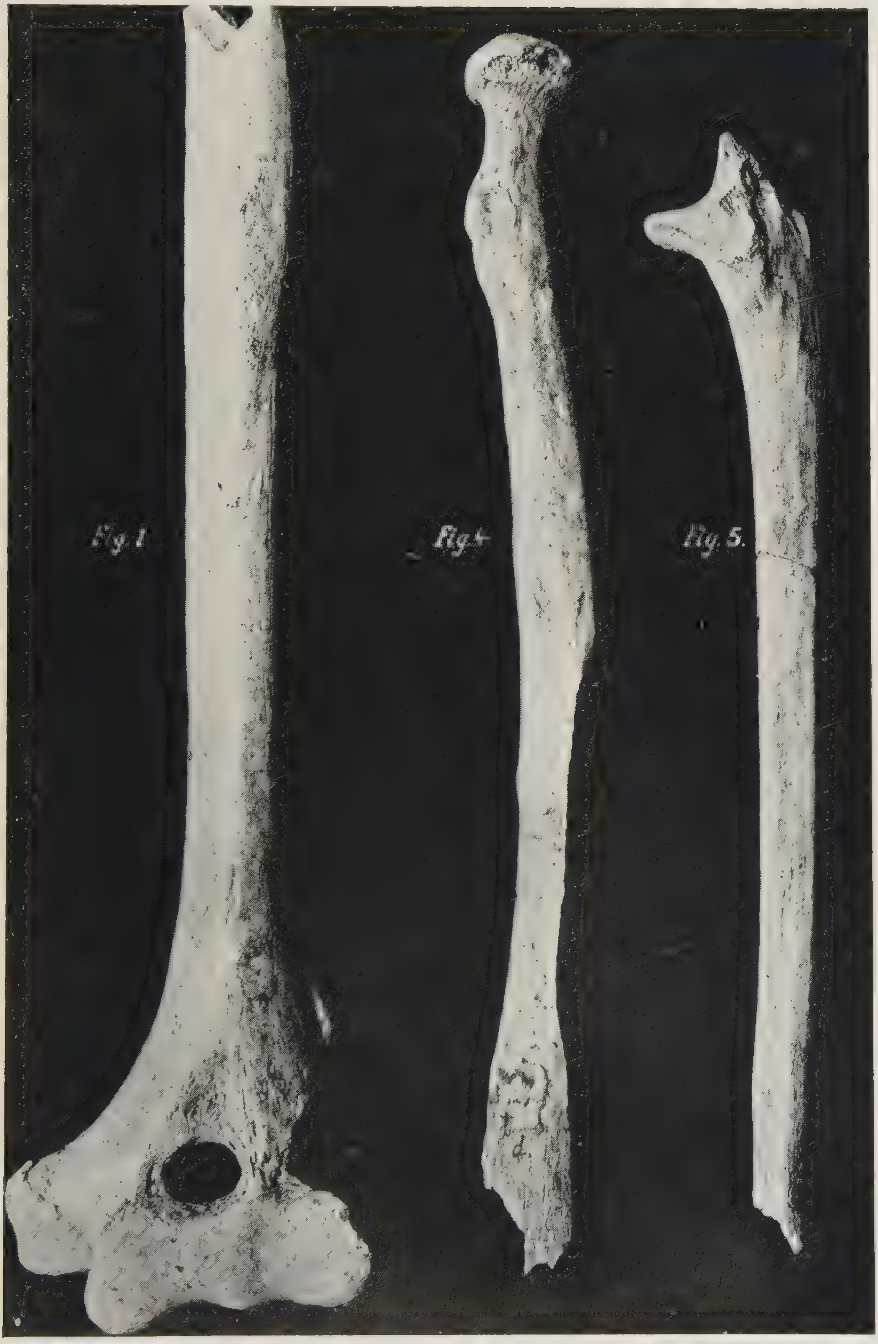
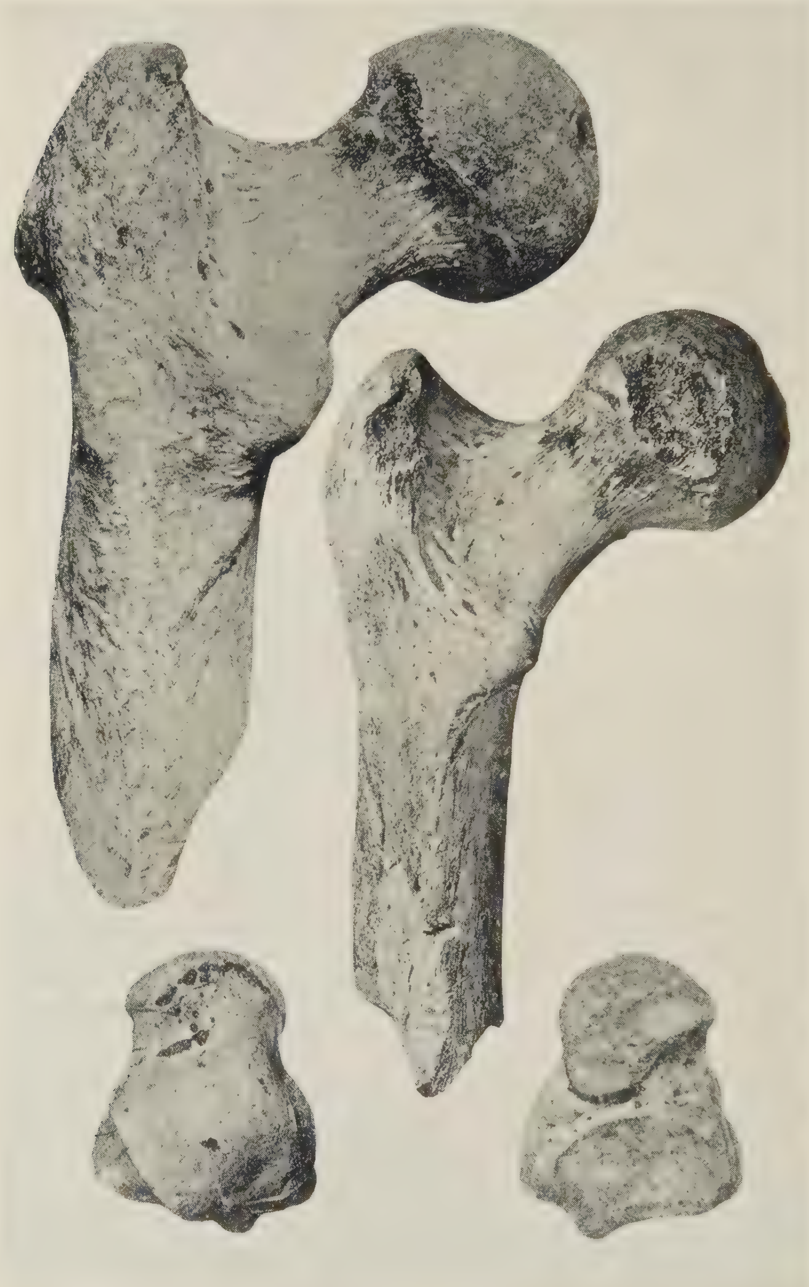


Fig. 1
Fig. 4
Fig. 5.

Krapina humerus, radius, and ulna. (After Gorjanović-Kramberger.)



Upper, the male and female Krapina femora.
Lower, Krapina astragalus. (All after Gorjanović-Kramberger.)

skulls has differed individually, in height, in breadth and other characters; and there is much of interest in this connection about the jaws and the teeth.

Of particular interest is the evident disposition of the Krapina crania towards brachycephaly, which thus far has not been known in early skulls. There have been some objections to the restoration of these specimens; the prejudice that could readily be created thus would be unjustified. The pieces that compose skull C appear clearly to belong to that skull, and those of D fit too well to involve any serious errors. An independent examination of the Krapina remains leaves no doubt but that they represent skulls both broader and shorter than those of the western Neanderthalers.

Gorjanović-Kramberger's opinion that more than one race of men is represented at Krapina cannot be sustained; the low jaws and weak bones are plainly those of females.

Adding to the variations and peculiarities of the Krapina skulls, jaws, and teeth, those of the skeletons, and contrasting the whole with what is known of the corresponding parts in the western Neanderthalers, it is plain that the Krapina man, while of the same general family, differs sufficiently to be regarded as a subtype which on the whole was morphologically somewhat more advanced towards later man. This is difficult to harmonize with a supposed greater age of the Krapina remains. Possibly he lived later than supposed, or he belonged to a more progressive group.

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[1] Mainly after Gorjanović-Kramberger.

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See also the various textbooks on Prehistory (though they contain but little detail and nothing original).

THE EHRINGSDORF REMAINS OF EARLY MAN

The little village of Ehringsdorf, in the Ilm valley, 3 km. from Weimar and about the same from Taubach, has become quite famous within the last two decades, on the one hand for its travertin quarries, which yield a very pure limestone (travertin), and on the other hand for the highly interesting animal and human remains that for many years have come to light and that are still appearing in these quarries.

The travertin deposits, of diluvial origin, extend from Weimar to beyond Ehringsdorf. At the latter place they are found in a low broad hill, on the slope of which the village is situated. For many years now, a part of the hill facing the moderate valley of the small

Ilm river has been blasted away for the limestone, the works being known as Kaempfer's Quarry. Herr Kaempfer, an educated man, was in fact still the owner of it during the writer's visits (1921, 1923), and is largely to be credited for the intelligent preservation of the paleontological as well as the human remains from his extensive workings.[1]

By 1914, the quarry reached the condition shown in plate 57. The exposed rocky wall approximated 40 feet in height and showed gross horizontal stratification. A little below the middle could be seen a belt about three feet thick known as the "Pariser," a largely consolidated loess formation; and beneath this, in the left part of the quarry, the writer was shown the remains of a flat pocket of more or less consolidated looser material in which stone implements had been discovered, with numerous evidences of human occupation.

It was in this layer or pocket, which lay about 10 feet below the "Pariser," that workmen began in April, 1914, to discover various fossil animal bones and some worked flints; and it was here that, on May 8, 1914, following a blast, there appeared, besides some animal bones, fragments of an adult human lower jaw. The bone had been both freed and partly shattered by the blast. In its vicinity were bones of various Quaternary animals, later identified as *Rhinoceros merckii*, cave bear, a *Bos*, a horse and a deer; also some bones that had been partly burned, some charcoal, and numerous flints showing human work.

The value of the find was, fortunately, promptly recognized, and the pieces of the jaw were most carefully gathered by Herr Haubold, the overseer, with the aid of Herr Lindig, the able Curator of the Weimar City Museum. The specimen was then most painstakingly repaired by Herr Lindig, and not long after turned over to Gustav Schwalbe for study. It is briefly described and pictured by the latter in October of the same year;[2] and not long after the specimen is referred to by MacCurdy.[3] Basing his opinion on its form and associations, Schwalbe considered the specimen to be a very valuable one, and referred it to the earlier period of Neanderthal man.

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[1] The writer is indebted to Herr Kaempfer for his courteous permission to examine the site and local collections, and for two valuable photographs of the quarry.

[2] Schwalbe, G., Über einen in Ehringsdorf bei Weimar gemachten Fund des Urmenschen. Correspondenz-Bl. allg. ärztl. Ver. Thüringen, 3 pp., 1914.

Über einen bei Ehringsdorf in der Nähe von Weimar gefundenen Unterkiefer des *Homo primigenius*. Anat. Anzeiger., Vol. 47, pp. 337-345, 1914.

[3] MacCurdy, G. G., Interglacial Man from Ehringsdorf near Weimar. Amer. Anthrop., Vol. 18, No. 1, pp. 139-142, 1915.

After Schwalbe's death a more complete study of the jaw was undertaken by Hans Virchow, and its description forms the main part of his masterly memoir on the human skeletal remains of Ehringsdorf.[1] While Virchow was engaged in the study, however, there came to light, on November 2, 1916, under similar circumstances and from about the same horizon but about 80 feet to the right and enclosed in rock, portions of the skeleton of a child about 10 years old. The specimen was badly damaged through the blast, but thanks once more to the most careful efforts of the quarrymen and Herr Lindig, all that could possibly be saved was secured and taken to the Weimar Museum. The parts consisted of six right and five left ribs, two vertebrae, the epistropheus, the right pelvic bone, half of the right humerus, incomplete lower jaw, and five teeth from the maxilla. The thoracic parts lie in a block of the stone and were found, with the rest of the defective parts of the skeleton, to be of but secondary scientific importance; but the lower jaw with its nine well preserved teeth was a document of value, and as such, was submitted also to Hans Virchow and is described in his Memoir with the adult mandible.

In addition to the preceding, several other finds of human remains were made in Fischer's quarry, lying immediately behind Kaempfer's workings. They include a number of fine stone implements and two pieces of a human parietal; they were, like the child's skeleton, enclosed in the solid rock. About 1922, in the right part of Kaempfer's quarry, a blast in the travertin above its middle revealed, the writer was told, a portion of a human femur. Fossil animal bones and worked flints were found on numerous occasions. On September 21, 1925, finally, a blast in the lower travertin of Fischer's quarry, in a block 55 feet (16.7 m.) from the surface, brought to light pieces of a young adult human skull. Of these additional human skeletal remains the skull, after a most painstaking disengagement from the rock and reconstruction, has been thoroughly studied and published on by Weidenreich.[2]

Geology.—The travertin or calcareous tufa deposits of the Ilm valley are found in three isolated nearby units, one at Weimar (left bank), the second at Ehringsdorf (left bank), and the third at Taubach (right bank). They are evidently intercalates formed during the latter half of the diluvial times in so many depressions.

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[1] Virchow, H., Die menschlichen Skeletreste aus dem Kämpfe-schen Bruch im Travertin von Ehringsdorf bei Weimar, 141 pp., 8 pls., 41 figs., Jena, 1920.

[2] Weidenreich, Franz. Der Schädelfund von Weimar-Ehringsdorf. Contains a section on the Geology of the deposits by F. Wiegers, and a section on the Ehringsdorf culture by E. Schuster, 204 pp., numerous illustrations, G. Fischer, Jena, 1928.

The Ehringsdorf unit is about 1,260 m. (over ⅔ mile) long by, at maximum, 400 m. (437 yards) broad, and from approximately 40 to over 60 feet thick. It reposes on meadow marl (1½ to over 3 ft. thick), beneath which is found a bed of river gravel (3 to 10 ft.); and its surface was covered by a substantial layer of humus.

The rock shows in general a considerable horizontal stratification; this, in Kaempfer's quarry, showed according to Pfeiffer (1917) the following:

From Above:

Layer	Meters[1]	
11	0.70–1.20	Humus.
10a	....	Sandy loam.
10	....	The "wild layer" of the workmen; clay with small embedded pieces of limestone.
9	0.90	The "black bank" of the workmen, gives good stone; poor in bones; no artifacts.
8	2.50	Thin layers of limestone, with blackish strips of probably humus origin; no bones or flints.
7	1.0	"Pariser"—a more or less consolidated formation that evidently consisted originally largely of loess. Few bones, some teeth of rodents, some shells of land snails. Flints scarce and unworked.
6	2.90	Group of three limestone banks, differing somewhat in color and density. A few artifacts and bones of animals.
5	0.30–1.0	Sandy tufa. The principal layer containing human remains as well as those of animals. The majority of the finds at Ehringsdorf, including both of the lower jaws and the child's skeleton, proceed from this layer.
4	2.60	The best quarry stone.
3a	....	Creviced and vacuolated stone; has yielded beaver teeth, eggs of the wild duck, and bones of some birds.
3	0.15	Pulverulent travertin, diluvial sand; poor in bones and artifacts, rich in snail shells (at Taubach the main stratum of bones and implements).
2	0.20–0.90	Meadow marl. Uppermost portion with lowest part of 3 gave a tooth of a mammoth.
1	Up to 3.0	Diluvial gravels, with isolated flints, with occasional teeth of the mammoth and *Rhinoceros tichorhinus* (Corgel, 1924).

[1] 1 m. (39.37 in.).

The origin of travertin units at and near Weimar has been ascribed since the time of Voigt (1781) to precipitation of lime from waters fed by mineral springs. The process of the building of the deposits was evidently very gradual, leaving an ample opportunity for human habitation about the pools. The German geologists ascribe the lower layers of the travertin to the last (Riss-Würm) interglacial; the upper limestone layers are doubtless more recent.

Fauna.—The most comprehensive details as to the fauna (and also the rather abundant flora) of the Ehringsdorf and neighboring travertin deposits, are given, largely after Soergel,[1] by F. Wiegers (1928).[2] From these it is seen that the fauna of the lower layers, beneath the "Pariser," differs somewhat from that of the strata above. The main mammalian forms in the two are as follows:

Lower strata	Upper strata
Rhinoceros merckii.	*Dicerorhinus hemitoechus.*
Rhinoceros tichorhinus (in the underlying marl and gravel, Soergel).[3]	*Rhinoceros tichorhinus.*
Elephas antiquus.	....
Mammoth (marl and gravel, to lowest limestone, Soergel).[4]	Mammoth.
Bison priscus (Bison).	*Bison priscus.*
Bos primigenius (Auroch).	*Bos primigenius.*
Cervus elaphus (Stag).	*Cervus elaphus.*
Cave lion.	....
Cave hyena.	....
Cave bear.	....
Brown bear (*U. arctos*).	....
Canis lupus (Wolf).	....
Canis vulpes (Fox).	....
....	Reindeer.
Equus abeli (Wild Horse).	....
....	*Equus hemionus* (Small Wild Ass).
Beaver.	....
Lutra lutra (Fish Otter).	*Lutra lutra.*
....	*Putorius put.* (Weasel).
Sus scrofa ant. (Wild Boar).	....
Cervus dama (Fallow Deer).	....
Cervus megaceros germ. (Giant Stag).	*Cervus megaceros germ.* (Giant Stag).
Cervus alces (Elk).	....
Cervus capreolus (Roe-Buck).	*Cervus capreolus* (Roe-Buck).
Felis catus (Wild Cat).	....
Felis lynx (Lynx).	....
Meles meles (Badger).	....
Mustela martes (Marten).	....

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[1] Soergel, W., Excursion ins Travertingebiet von Ehringsdorf. Paleont. Zeitschr., pp. 7-33, 1926.

[2] In the joint publication, Der Schädelfund von Weimar-Ehringsdorf, p. 18 *et seq.*, G. Fischer, Jena, 1928.

[3] *Ibid.*, p. 9.

[4] Close to if not identical with, *Rhinoceros merckii:* see *ibid.*, p. 20.

Industry.—The Ehringsdorf stone industry has been very carefully and ably studied by Erich Schuster.[1] It shows relatively over a score of types in flint and local stones and, as with other early industries in Germany, is not very harmonious with industries of similar age in France. The artifacts differ in workmanship from relatively simple to very well shaped, and belong apparently to the Middle Paleolithic. A typological classification is as yet impracticable. Climatic conditions as well as most of the materials were different in Germany from those in France. German prehistory must largely reach its own order and chronology. Critical considerations of the case show that the period deserves the distinctive name of the "Weimar Culture." Exactly where it belongs must be left to further study.

THE SKELETAL REMAINS

Thanks to Herr E. Lindig, Curator of the Städtisches Museum, Weimar, where all the originals from Ehringsdorf are preserved, the writer has twice been able (1922, 1923) to examine the earlier originals from Ehringsdorf, namely the two lower jaws, the child skeleton, and the worked stones. If the writer's own observations are here used rather than the very able report and detailed data of Hans Virchow, it is only to insure greater uniformity as well as originality in this work; but the student is urged to consult also the highly meritorious memoir previously mentioned.

THE ADULT LOWER JAW

The Jaw is that of an adult of somewhat advanced years, judging by the condition of the teeth. The teeth show what the student of primitive people would call about medium wear, ranging in the different teeth from complete abrasion of the cusps as in the left M2 and the four premolars, to complete wear of the crown, as in the two remaining incisors. The jaw is of moderate size for an early jaw, and judging by the relative lowness of the body it belonged probably to a female. It is a remarkably primitive specimen in many respects, yet it shows already several prospective or advanced features. The dental part of the jaw is relatively long and narrow, approaching the form of a long **U**; the outline of the lingual contour of the bone itself is that of a regular, moderately narrow, dull cone.

The teeth were 16 in number (14 remaining). They are of modern, somewhat macrodont type, but the molars are relatively rather narrow

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[1] Der Schädelfund von Weimar-Ehringsdorf, p. 141 *et seq.*, 1928.

(see the special section on teeth). The third molars are distinctly smaller than the first and second, particularly on the left where the tooth can only be characterized as diminutive. None of the other early jaws so far known shows the reduction of the M3 to such a degree. The roots of the incisors—all that remains of them—are somewhat wider antero-posteriorly than even in macrodont jaws of today. The canines and premolars, and the cusp foramen of M1 and M2, were very much as they are in jaws of corresponding strength in modern man.

The bone, although not very massive, is distinctly stouter than a large majority of jaws of today, particularly those of females. The thickness of the ramus at M2, very nearly the same on the two sides, reaches 15 mm. The body was low, its height at M2 having probably not exceeded 28.5 mm. Anteriorly the jaw shows a recession, but one of a somewhat peculiar kind, and a marked dental prognathism. The part has been affected and somewhat altered by dental abscesses, yet the main conditions are quite discernible.

Had it not been for the dental prognathism, the symphyseal region would have been only slightly receding from the vertical (with the jaw lying naturally). It was somewhat flattened anteriorly as are the Krapina jaws; and like some of these it has a distinct though small chin eminence. The inferior border of this portion shows a moderate cupid's-bow outline, with a rather marked little beak in the middle, approaching thus again some of the early jaws. The mental foramina are single, unusually large, and situated on the left below the center, on the right below the posterior half of M1. These are primitive features, much like those of the Krapina and other early mandibles. Between M3 and the anterior border of the coronoid processes there is seen a marked gap, yet another characteristic of early mandibles.

The ascending rami show considerable flaring out, so that while the body of the jaw is narrow the intercoronoid and the intercondyloid diameters were evidently rather large. The rami were relatively slender (in thickness), and there may have been a well-defined mandibular angle; but this region with the posterior and upper portions of the ramus are so damaged that nothing positive can be said about them. Inferiorly, from the midline to beneath the mental foramina on each side, the jaw is flattened and rather deeply impressed for the attachment of the digastric muscles—approaching the condition in other early jaws; further back, however, the border of the bone is dull, fairly slender and much like that in modern mandibles.

Lingually the body of the bone shows very interesting features. Beginning from above in the incisor and premolar region, the bone slants inward and downward, and a marked inclined shelf is formed that reaches, gradually diminishing, to the molar region. The lower border of this sheif, when looked at from below, constitutes a marked ridge that extends all along to behind the last molars; and underneath this border is a distinct continuous groove extending bilaterally from the symphysis to considerably behind the M3, where it shallows out somewhat and merges with the pterygoid fossa of the ramus. There is no trace of a vertical symphyseal ridge or of any distinct anterior fossa above the epimedial ridge; but below this ridge is a low triangular elevation merging with that of the glenoid tubercles, which, in a measure, subdivides the submedial groove into left and right portions, with a somewhat more marked depression on each side of the median line. Such a complete epimedian ridge, with such a distinct and practically continuous submedian antero-posterior groove, is not equalled in any of the other ancient jaws, and is represented only in occasional traces in modern man. The epimedian ridge in the Ehringsdorf specimen is directly, and without any mark of junction or interruption, continuous with the mylohyoid ridge. But little can be said about the lingual surface of the ramus; what there is may be duplicated in every particular in modern jaws.

The prospective or advanced characters of the jaw are, therefore, its slight true symphyseal recession; its distinct mental eminence; the modern forms and in the main also the size of the teeth; the markedly diminished third molars; and in general the characters of the ramus. Features in which, on the other hand, the jaw approaches those of apes, are especially the upper lingual shelf with the anterior submedial fossa below it; the relative narrowness of the teeth; the general shape and relative dimensions of the body of the bone and the dental arch; and the flattening from side to side of the precanine region, this being a remnant of the early human and prehuman powerful development of the roots of the canines.

THE LOWER JAW OF THE CHILD

The specimen is marked by its stoutness (thickness of body at M1, 16.5; at symphysis, 16 mm.); by its flat and moderately receding symphyseal region with a very slight but distinct chin eminence; by a **U**-shaped dental arch; by the relatively narrow molars; and by a broad and high coronoid process. It was probably the jaw of a male child.

The mental foramen is indistinct, the region having been damaged on the left, while on the right all of the bone posterior to Pm1 is missing. The height of the body at the symphysis is 30 mm.; at M1, 24 mm. The height of the ramus (Hrdlička's method) is 5.5 cm.; breadth min., 3.7 cm. Lingually the anterior portion of the jaw shows a marked epimedian simian shelf, much as in the adult jaw. This shelf, however, is marked below by only a very moderate dull ridge beneath which is a fairly distinct submedial uniform fossa extending on each side up to Pm1, without any elevation for the genial tubercles. This fossa is rounded beneath by a fairly distinct border which is the lingual border of a flat and fairly uniformly broad inferior surface stretching up to behind Pm1, after which the lower border assumes a shape that is practically identical with the modern. The mylohyoid ridge is not yet very marked and does not unite with the epimedial anterior border, as it does in the adult jaw.

The rami show a shallow notch, broad, stout and high coronoid processes, stout condyloid processes, a marked dorsal depression below and behind the coronoid; while ventrally there is a stout coronoid "root," with a trace only of the condyloid ridge, both uniting at about the level of the mandibular foramina (in ordinary position), and merging with the mylohyoid elevation. There is also a strongly marked fossa for the internal pterygoid. The angle of the ramus, still somewhat rounded and thus reminding of prehuman or early human conditions, is nevertheless already so formed that it can readily be duplicated in modern mandibles. The mandibular angle is much like that in modern jaws (approx., 122°). The ramus shows already a marked eversion, indicating a relatively broad (as compared to the body) bicoronoid and bicondyloid diameter—as in the adult. The jaw is a primitive specimen and approaches closely some of the Krapina mandibles.

There are nine teeth, with the crown of the M2 visible still deep in its socket. The four incisors are completely erupted. They are relatively large—larger than in any modern jaws and stout anteroposteriorly. The right permanent canine (left lost) is nearing the completion of its eruption; it is much like the incisors, only stouter (linguo-labially). The right anterior premolar, crown erupted, is large with a high and stout labial cusp. The left second premolar, just showing, seems slightly less stout than Pm1, for its labial cusp is lower. Between the left Pm1 and M1 is the still remaining posterior molar of the milk dentition. The M1, fully erupted, shows five cusps and a marked precuspidal fossa.

Additional teeth.—In addition to the teeth in the lower jaw of the child's skeleton, there are also present the two right upper incisors of the same subject. These incisors resemble much the corresponding teeth of Krapina. They are distinctly shovel-shaped, and present lingually from one (median I) to three (lateral I) marked small cusps.

THE PARIETAL BONE

This piece is not described by Virchow. It is a large oblique fragment of the left parietal with large portions missing antero-superiorly and postero-inferiorly. It apparently proceeds from a juvenile, though hardly a child's skull, is of moderate thickness (maximum, 8.5 mm.) and shows one important feature, which is a marked and nearly central parietal eminence, not dull, posterior and low down as in the Neanderthalers, but practically like that in modern man.

THE 1925 SKULL

This original, which the writer has not yet seen, has been described thoroughly by Professor Weidenreich. It is a specimen of uncommon importance, for it shows, as does Spy No. 2, transition from the Neanderthal to the modern form of skull. The specimen presents some of the distinctly Neanderthaloid characteristics, such as a complete and still rather heavy torus, and the somewhat protruding broad occiput, flattened from above and hollowed out below, typical of the Neanderthal crania. But with these inferior features there is a higher and well arched forehead, a higher vault, a better developed mastoid, a less heavy zygoma, and a parietal with a central rather than posterior, though still low situated, eminence.

Weidenreich's conclusions as to the skull, to the restoration of which he gave the most meticulous care, are as follows:[1]

The skull, which came from the lower travertin of Fischer's Quarry at Ehringsdorf, belonged to a young individual (between 18 and 30 years of age), possibly a female [?]. Unmistakable dents on the frontal made partly by sharp, partly by dull stone implements, render it probable that the individual had been killed. The violence resulted also in breaks of the cranial bones and separation at sutures. The fact that the basal parts of the skull are missing, having apparently been broken away, lead to the conclusion that the skull was thus broken for the purpose of the extraction of the brain [cannibalism]. The damaged skull was apparently thrown into a pool of water and became enclosed in the forming limestone. After the drying up of the pool the bones evidently became separated in the still plastic mass and broken further.

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[1] Weidenreich, Franz, Die Morphologie des Schädels; in Der Schädelfund von Weimar-Ehringsdorf, p. 135, Jena, 1928.

The skull possesses the following characteristics of the Neanderthal group: Complete supraorbital arches; protrusion of the glabella region [though the glabella itself was in a fairly well marked depression]; large intraorbital and upper facial breadth; Neanderthaloid occiput; a shallow and broad (transversely) glenoid fossa, and primitiveness of some parts of the temporal bone. But it shows a well arched forehead and a strong filling out of the anterior portion of the vault, which characters raise it above the *Homo primigenius* group and into the palaeolithic forms of *Homo sapiens*.

Together with the Galilee specimen and probably also with that of the Podkumok, the Ehringsdorf skull is to be ranged in an intermediary group. At all events, the exceptionally large breadth of the forehead and of the upper face characterize the Ehringsdorf man as a separate race which was characterized also by exceptional features of the lower jaw. Both the earlier found lower jaws belong to the same morphological type. None of the characteristics of the skull permits the supposition of any postmortem deformation.

Professor Weidenreich gives also a table of approximate measurements reached by him on the reconstructed skull. They are as follows:

	cm.		cm.
Length max.	19.6	Diam. frontal max	12.1
Length glabella-inion	19.2	Greatest breadth of the occipital squama	10.5 (?)
Length nasion-inion	18.4	Calotte-height (above glabella-inion line, projection)	9.6
Greatest breadth	14.5	Calotte index	*50.0*
Cranial index	*74.0*	Upper facial breadth	13.3
Inside length	17.1	Anterior interorbital breadth.	3.0 (?)
Inside breadth	13.45	Skull capacity	1,450 cc. [?]
Inside or brain breadth-length index	*78.65*		
Diam. frontal min	11.3		

CRITICAL NOTES

The writer's examination of the Ehringsdorf originals, coupled with the study of the most recent skull and implements of which there are able descriptions, leads him to the following views:

The originals in Weimar, and the plentiful fine illustrations of the artifacts in Schuster's report (1928), show plainly, especially in the knives and scrapers, Mousterian affinities. But the long and other fine points, including the remarkable double-point, the drills, and other objects, suggest more advanced development. There is certainly nothing very primitive about the culture, though a few of the worked stones are rather crude or simple.

Similarly with the human skeletal remains—they are certainly not more primitive than those of the Neanderthalers. They are on the whole less primitive, in fact, than the Neanderthal remains proper, or the La Chapelle, or Le Moustier, or the adult Gibraltar. The lower jaws come close to most of those of Krapina, and so do the two upper incisors as well as other teeth. The fauna also resembles in the main that of Krapina. The Krapina industry, in the main Mousterian, is also somewhat aberrant, though whether these aberrations are near those of Ehringsdorf is uncertain; both may be quite local and differing from each other.

The presence of *Rhinoceros merckii* both at Ehringsdorf and Krapina is neither proof of contemporaneity of the two sites, nor that either of them is of greater antiquity than the French and Belgian Mousterian sites where this form has not been encountered. The presence of the remains of *R. tichorhinus* at a lower horizon, as reported by Soergel,[1] shows that the older form (*R. merckii*) survived for some time at least after the coming or development of the newer.

The assumption of the German writers that the Ehringsdorf man, or at least he of the older strata, lived well into, if not throughout, the third (Riss-Würm) interglacial, and a similar assumption about the Krapina man, while the other Neanderthal remains are usually believed to straddle, chronologically, the last or Würm glaciation, seems incongruous and involves chronological, faunal, cultural, as well as somatological difficulties. The question arises whether the Ehringsdorf stratum could not be attributed to a warmer intermediary period of the last glaciation itself, rather than to the preceding, supposedly long, interglacial period. The cultural and somatological evidence, at least, would seem to favor this conception. We strike here the well-known difficulty of harmonizing the Mousterian time, and especially its beginnings, with the current and especially the German geological-paleontological deductions as to the periods follow-

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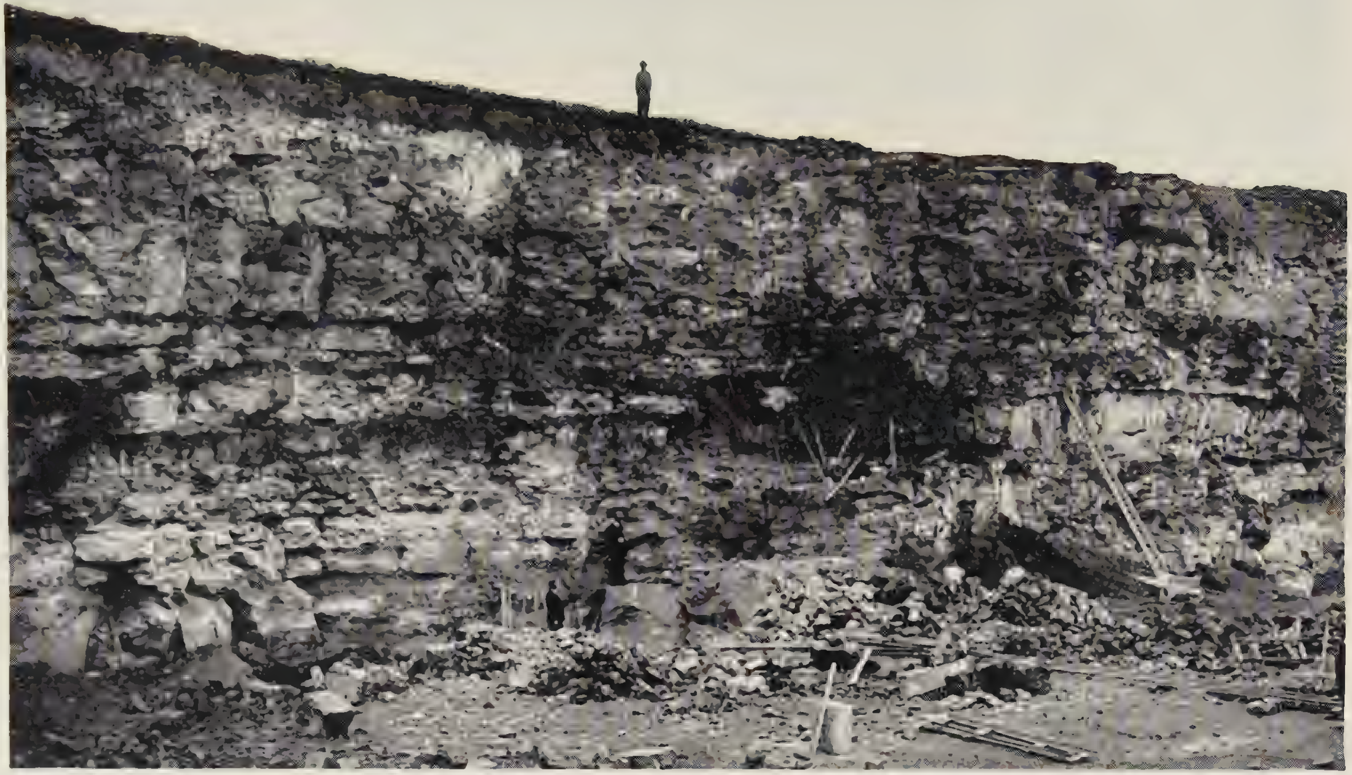
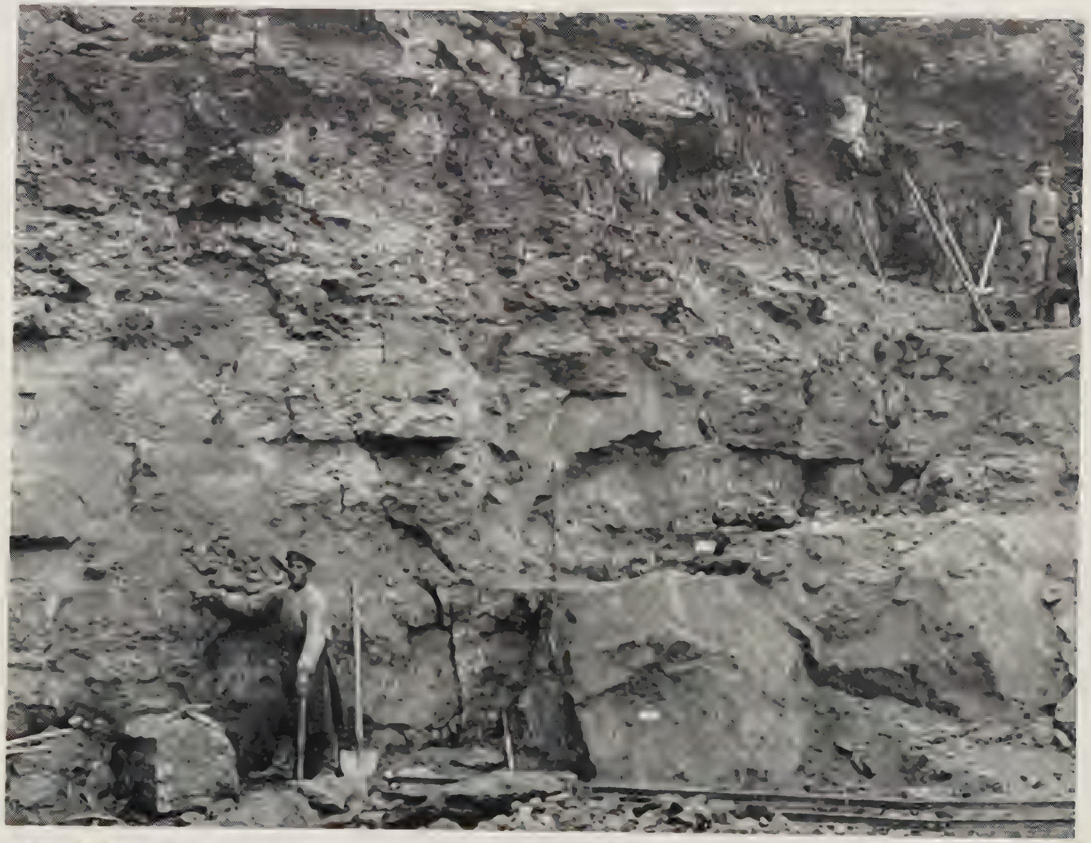
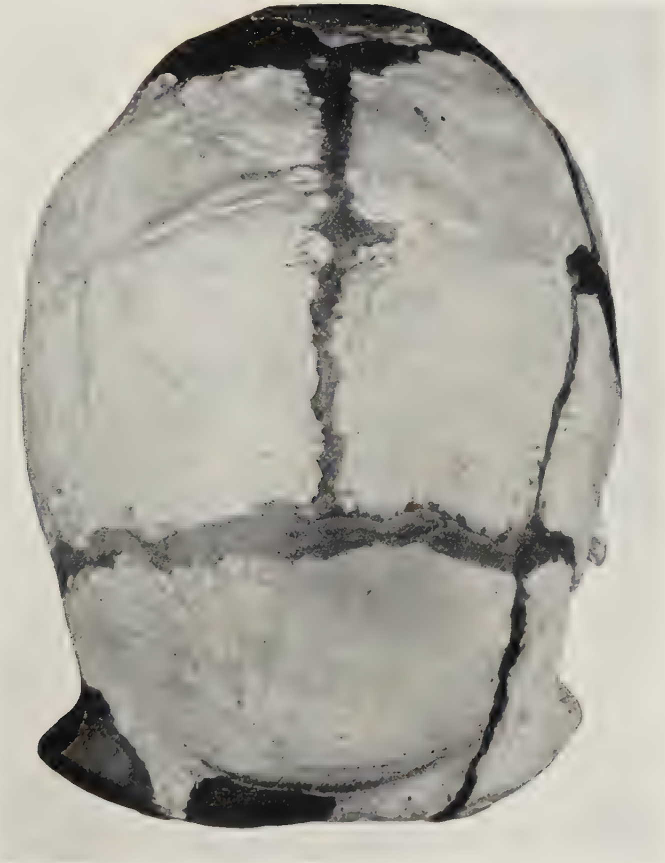
[1] See Wiegers, in Der Schädelfund von Weimar-Ehringsdorf, p. 9, last par., 1928.



General view of Kaempfer's Quarry, Ehringsdorf. A white spot to right of man standing on a block indicates stratum in which the adult lower jaw was found. (Photograph donated to Hrdlička by owner of the quarry.)



Kaempfer's Quarry, Ehringsdorf, showing where lower jaw (level to which man points) and child's skeleton (lower white mark) were discovered. (Photograph donated by the owners of the quarry.)



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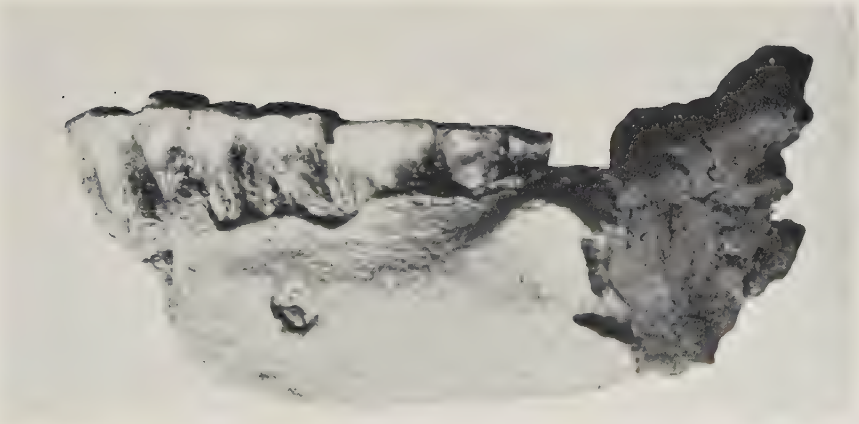

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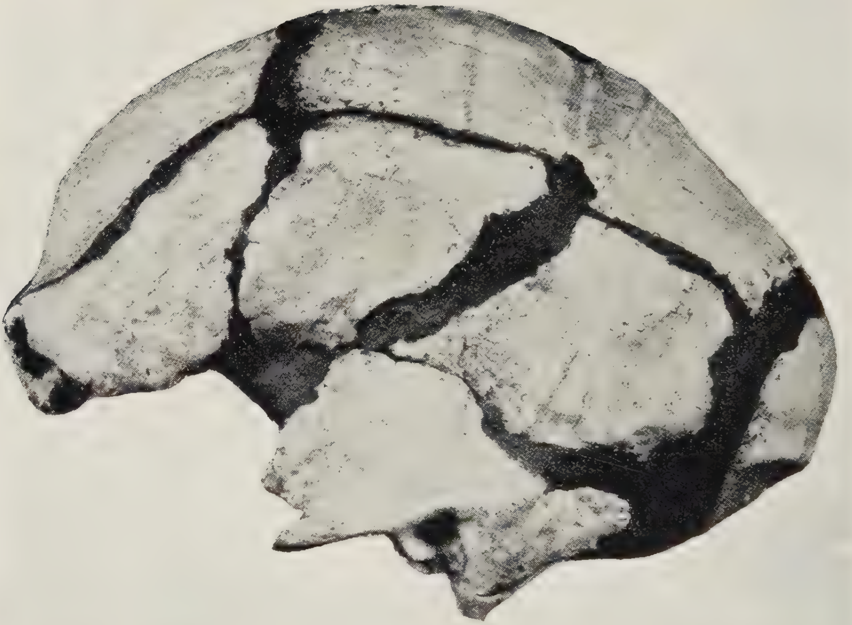
1. The Ehringsdorf skull (1925), top view. (After Weidenreich.)
2. The adult Ehringsdorf jaw.



The Ehringsdorf skull (1925). (After Weidenreich.)

ing the main (2nd) Interglacial. It is most desirable that there be reached, as soon as practicable, a consensus of scientific opinion on these questions.

The quarry work at Ehringsdorf proceeds, and with the intelligent interest in the finds of the owners, the overseers, and even the workmen, and the nearness of Herr Lindig, it seems justifiable to hope that new discoveries will be made which will throw additional light on the highly interesting problems of the ancient Ilmstal population.

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THE TAUBACH FINDS

Among the isolated specimens proceeding from early man are the two teeth of Taubach. One of these, a molar of the first dentition, was found in the Quaternary deposits at Taubach near Weimar, Germany, in 1892, by A. Weiss. The crown of this tooth shows considerable wear, and this fact, with various characteristics of the specimen, created at first an impression that the tooth was perhaps not human; later, however, the tooth was accepted as proceeding from a human child. Meanwhile one of the laborers at Taubach discovered in supposedly equally old deposits a first permanent left lower molar about the human nature of which there can be no question, and this tooth also shows various primitive features. Both these finds have been reported upon and the specimens described by Nehring.[1] The permanent molar is preserved in the museum of Jena.

The site of Taubach, close to the village of the same name, lies in a terrace bordering the Ilm valley, not far from Ehringsdorf and but a few miles from Weimar. The terrace is built up of calcareous tufas alternating with sand. As early as 1874, excavations for the sand and stone began to disclose an ancient fauna, and with it traces of paleolithic human remains.

The fauna is characterized by *Elephas antiquus* and *Rhinoceros merckii,* and is believed to date from a warm interglacial period. The artifacts comprise articles in stone, bone, and horn. The implements of flint, quartz, and other stone, lack characteristic forms; they are indefinite as to type, some approaching Mousterian forms, others appearing more primitive. Among the bone implements are numerous axes [or scrapers?] made of bear mandibles, scrapers of beaver jaws, a bone knife or disk, horn clubs or hammers, and other forms.

DESCRIPTION OF THE TEETH

The first human tooth was found in 1892, in the " Mehlhorn trench," at a depth of 5.10-5.25 m. (nearly 17 ft.), by Dr. A. Weiss, while the latter was collecting fossil animal skulls. The tooth showed similar alterations as did animal bones from the same layer. The specimen is described in 1895 by Nehring.[2] It has been identified as the anterior left lower milk premolar. A question arose at first as to whether the tooth was human, but the identification as such has been generally accepted.

The crown of the tooth shows some wear. It measures 8.8 mm. in length (ant.-posteriorly); 7.5 mm. in breadth (linguo-labially); the length is much the same as that of corresponding teeth in uncivilized modern races, the breadth is slightly greater. The drawing of the crown that accompanies Dr. Nehring's report is a rather poor one and the double-size enlargement accentuates its defects. In essentials the foldings of the enamel are much like those of today. In 1923, the tooth was said to be still in the possession of Dr. Weiss and the writer was unable to reach it.

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[1] Götze, A., Die paläolitische Fundstelle von Taubach bei Weimar (with earlier literature). Verh. Berl. Ges. Anthrop., pp. 366-377, 1892. Schötensack, O., Diluviale Funde von Taubach. Verh. Berl. Ges. Anthrop., pp. 92-95, 1895. Nehring, A., Über einen fossilen Menschenzahn aus dem Diluvium von Taubach bei Weimar. Verh. Berl. Ges. Anthrop., Zeit. Ethn., pp. 338-340, 425-433, 1895. Same author, Über einen menschlichen Molar aus dem Diluvium von Taubach bei Weimar. (*Ibid.,* pp. 573-577.) See also Adloff, Das Gebiss des Menschen und der Anthropomorphen, Berlin, 1908; Schmidt, R. R., Die diluvial Vorzeit Deutschlands, Stuttgart, 1912; and Festschrift Anthropologische Versammlung Weimar, 1912.

[2] *Op. cit.,* pp. 338-340, 1 fig.

About the second tooth there was for a time some uncertainty, but Dr. Nehring's local inquiries appeared to establish the authenticity of the specimen.

The tooth is the left lower permanent first molar. It proceeds from the same stratum as the milk tooth in the " Sonnrein " excavation. It was found by the owner and worker, H. Sonnrein, secured by Professor Klopfleisch, and eventually deposited in the Jena Museum. The formation at this place was as follows:

		Meters	
1.	Humus	0.30	15.19 feet
2.	Slab limestone	0.80	
3.	Fine-grained limestone with numerous snail shells	0.17	
4.	Harder plant limestone	0.19	
5.	Hard limestone (travertin)	0.22	
6.	Ochreous hard limestone	0.20	
7.	Black loose stratum	0.13	
8.	Travertin	1.59	
9.	Grey argillaceous limestone	0.20	
10.	Ochre	0.03	
11.	Fine-grained limestone	0.80	
12.	Fine-grained often sandy limestone, with animal bones and the two human teeth	0.45	....18 in.

The crown of the tooth is 11.7 mm. long, 9.9 mm. broad [module 10.8, B-L index *84.6*]. In size the tooth can be matched in man of today. But its relative breadth and the index are decidedly low for a human tooth. They exceed those of any of the other early teeth (see section on " Teeth "). The only known permanent lower first molars that equal the Taubach tooth are those attributed to the *Dryopithecus suevicus* (*rhenanus*), and those of the chimpanzee.

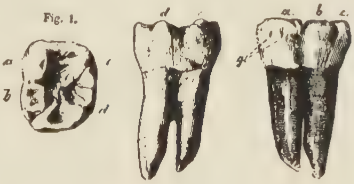

FIG. 21.—The molar of Taubach. (After A. Nehring, 1895.)

The conformation of the crown, and the roots, while offering some points of interest, are on the whole much like those of man. Nehring considered the folding of the enamel with some particulars as to the cusps to be somewhat chimpanzee-like, but nevertheless identified the tooth as human. Schwalbe classed it with the Neanderthal remains.[1] For Duckworth,[2] it was difficult to decide whether it was a human tooth or the tooth of a pithecoid precursor of man. Miller, and with him, Gregory, regard the tooth as belonging to a Pleistocene chimpanzee (*Pan vetus,* Miller).[3] For Marcellin Boule, " it is possible that it may have belonged to a man related to the Neanderthal type."[4]

Today, after additional study of the tooth, G. S. Miller, Jr., informs the writer that he considers his earlier identification of the tooth as erroneous, regarding it now as a human tooth with some primitive characters. In the opinion of the writer, who saw the original in 1923, the tooth is clearly of a human type, though it is relatively slightly narrower than any human M1, ancient or recent, that he has seen so far.[5]

The atypical Taubach industry which has been referred by different authors to everything from Chellean to Mousterian, is now regarded as representing most probably the warm or older Mousterian and as closely allied to the Micoque culture.[6]

THE PLEISTOCENE MAN OF JERSEY (ENGLAND)

In 1910 Messrs. Nicolle and Sinel, of the Island of Jersey, gave notice in *Man,* and in a bulletin of the Jersey Society,[7] of the discovery, in an old cave on the Island of Jersey, of 13 highly interesting human teeth, belonging to a man of the Mousterian period. The principal details of the find, according to the clear account presented by the two authors and confirmed later by the writer's observations on the spot, are as follows:

The cave where the ancient human remains were found is known as La Cotte, or La Cotte de St. Brelade, and is situated in a great

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[1] Die Vorgeschichte des Menschen, 1904.

[2] Prehistoric Man, p. 23, Cambridge, 1912.

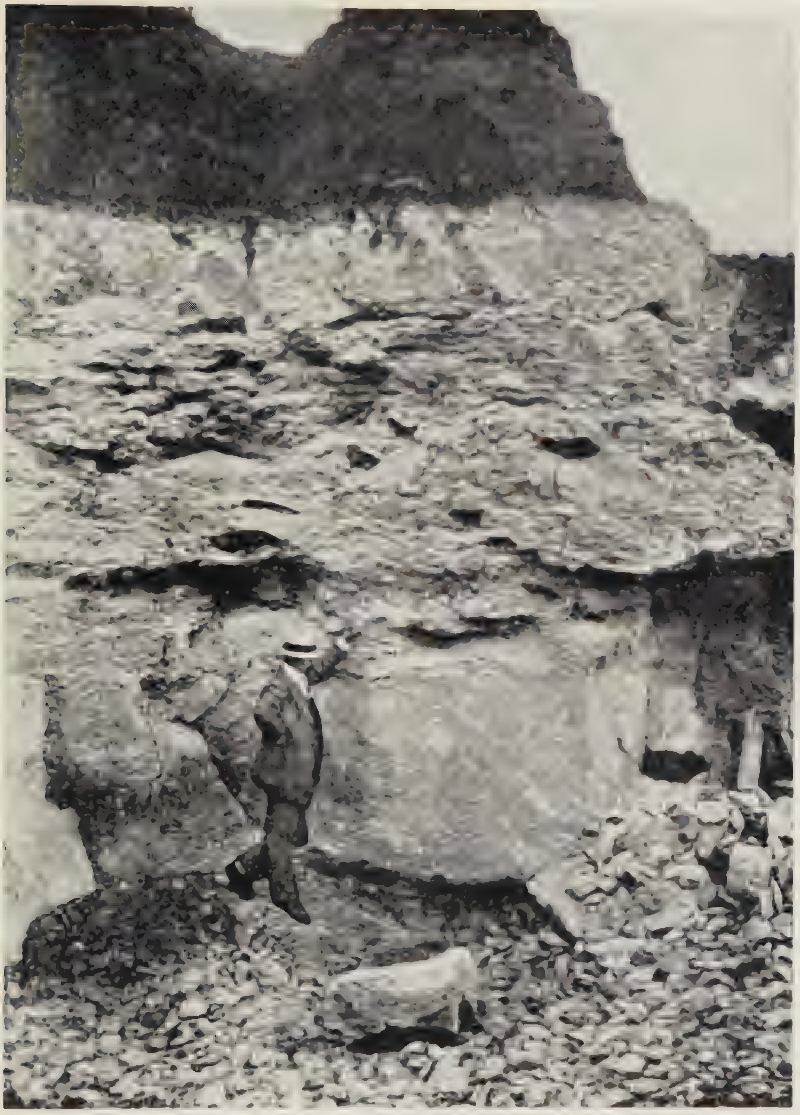
[3] Gregory, W. K., Studies on the Evolution of Primates. Bull. Amer. Mus. Nat. Hist., Vol. 35, 1916.

[4] Fossil Men, p. 146, 1923.

[5] Hrdlička, A., Variation in the Dimensions of Lower Molars in Man and Anthropoid Apes. Amer. Journ. Phys. Anthrop., Vol. 6, No. 4, pp. 423-438, 1923.

[6] Werth, E., Der fossile Mensch, Vol. 2, p. 512, 1927. See also, Schmidt, R. R., Die diluviale Vorzeit Deutschlands, Stuttgart, 1912.

[7] Nicolle, E. T., and Sinel, J., Report on the exploration of the palaeolithic cave dwelling known as La Cotte, St. Brelade, Jersey. Man, Vol. 10, No. 102, pp. 185-188, 1910. Reprinted in 36ᵉ Bulletin de la Société Jersiaise, p. 69, Jersey.



The calcareous tufas of Taubach. (After Eichhorn.)

rough irregular cliff near the eastern horn of St. Brelade's Bay, Jersey. At this part of the island granite rocks, considerably weathered and broken, rise steeply to about 200 feet above mean tide level, the shore at their base being covered with accumulations of large, rounded, waterworn bowlders (pl. 61). In one part of these cliffs there is an irregular rough ravine or gorge, which penetrates about 150 feet into a cliff. The side walls of this ravine are, in large part, quite vertical; and in the wall on the left, near the upper terminus of the gorge, is a large cave which bears the above name. Before its exploration the La Cotte cave was nearly filled by clay, débris and blocks fallen from the much-weathered roof; while rubble drift, in the form of a steeply sloping talus, lay in front, obscuring a large portion of the mouth. Removal of this drift revealed the outline of the opening in the form of an irregular arch.

The first indication that the cave was once utilized by man dates from 1881, when two local naturalists, while "geologizing" on that part of the coast, found a flint implement at the foot of the talus, and, tracing its source, came upon a slightly exposed section of the cave floor. There they found flint chippings and one or two bones, apparently of a large bird; but no importance was attached to the discovery. About 1894, two members of the Société Jersiaise, Mr. R. Colson and Dr. Chappuis, excavated a portion of the exposed floor section of the cave and found a considerable number of flint implements, and besides that a quantity of bone breccia which contained one tooth and one metatarsal of a variety of horse. Subsequently various partial examinations of the accumulations in the cave resulted in the discovery of implements, and of a large number of flint chippings. All these are preserved in the Museum of the Société Jersiaise, at St. Helière.

In September, 1905, the Jersey Society decided to explore the cave systematically, and Dr. Chappuis, Mr. Nicolle the secretary, and Mr. Colson, commenced work in the part of the exposed floor already mentioned. More flint implements were discovered, but early in October the task had to be abandoned owing to the rainy season and to the fact that the workers were excavating under dangerous conditions. It became clear that a considerable portion of the talus as well as some of the threatening rocks overhead would have to be removed before the work could proceed.

Thus matters remained until July, 1910, when the society resolved to make another attempt at the exploration of the cave. With the help of experienced quarrymen excavation was commenced on August

1, and after a little over three weeks' work sufficient of the rubble had been removed to reveal the form of the interior of the cave, and to lay bare a portion of the floor about 11 feet square to the left of the entrance. The dimensions of the cave as seen at this stage were as follows: The entrance was 25 feet in height and about 20 feet in width. Just within, the roof sloped upward into a rough dome 30 to 32 feet from the floor; how far the cave entered the rock could not be ascertained, but judging from the slope of the roof towards the back, it was probably some 40 to 50 feet.

As soon as a portion of the floor had been reached, a careful search and examination were commenced, with the following results:

The floor was not well defined. It consisted of compacted layers of black soil, which proved to be a combination of ashes, carbonized wood and clay, mixed with whitish bone detritus. Flint implements and chippings were interspersed plentifully throughout these deposits. On the left of the entrance and at a distance from it of about 8 feet, was a hearth containing a large quantity—probably a quarter of a ton or so—of wood ashes and carbonized wood. Close together, among the ashes of the hearth, were a few pebbles of granite and felsite bearing indications of having been heated.

The presence of bones was manifest all through the layers constituting the floor, but due to advanced decomposition of the material, the cave not being a dry one, only here and there could fragments retaining any form be obtained. Nevertheless in one corner, at a slightly higher elevation than the hearth, there was found a mass of bone from which some determinable portions could be secured; and a careful examination of this mass, after its transference to the Jersey Museum and treatment with gelatine, led to the most important result of the excavations to this time, namely, the discovery of nine human teeth. Four of these were from the upper, five from the lower jaw. They represent, as was later determined, teeth of both sides and of one individual, but unfortunately no trace of the once supporting bone was any more apparent. All the bones and teeth recovered from the cave were taken to the British Museum for determination, and Drs. Smith Woodward and Andrews identified the specimens as follows:

ANIMAL TEETH: Part of left lower premolar of the woolly rhinoceros, *Rhinoceros tichorhinus;* last premolar and first molar of reindeer, *Rangifer tarandus* (a large species apparently as large as the caribou); upper cheek teeth of a small species of horse; parts of lower molars and upper cheek tooth of a large species of horse; lower teeth in portion of jaw of one of the small Bovidae; and left incisor of *Bos,* Spec.?

NINE HUMAN TEETH, with subsequent recovery of four others.

BONES AND HORNS: Part of horn core of one of small bovid; portion of antler of reindeer; bone, probably from articulation of foreleg of a deer; pelvic bones, probably from a small bovid; and a piece of bone, which fell to pieces on removal, from a rhinoceros.

Among the fragments that could not be definitely determined was also apparently a portion of a human tibia. Of flint instruments about 100 have been obtained. They are, without exception, of the well-known tongue-shaped Mousterian type, the "pointe à main" of Mortillet. The cave gave no evidence of other than one occupation, and is thus probably free from the confusion which results when implements and remains of the fauna of different periods occur together and have become mixed by the work of burrowing animals, water during floods, and other agencies, as is often the case in similar deposits. By their fauna and the uniform type of stone implements, the La Cotte cave deposits are shown clearly to be of the Mousterian period.

Further explorations of the site were carried on under the auspices of the Jersey Society in 1911 and again in 1912. They are reported by Nicolle and Sinel and by Marett.[1] They threw considerable light on the nature of the cave and its filling, and were extended to what may prove to have been a part of the same hollow on the base of the wall of the opposite side of the gorge. They resulted in the discovery in both caves of numerous additional flint implements, all of the Mousterian type, and in the older excavation of more fragments of animal bones, referable principally to the woolly rhinoceros, the reindeer, a large variety of horse, and probably the *Bos primigenius*. But no further human bones or teeth came to light.

Meanwhile the human teeth (pl. 62) were subjected to careful examination by Prof. Keith, of the Royal College of Surgeons, and Mr. Knowles, of the Oxford University. The results of these studies were published in 1911 in the Journal of Anatomy and Physiology,[2] and later, with some additions, in the thirty-seventh bulletin of the Jersey Society. The following embraces the gist of these reports, as well as of the writer's own observations.[1]

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[1] Nicolle, E. T., and Sinel, J., Report on the Resumed Exploration of "La Cotte," St. Brelade, by the Société Jersiaise, 1911. Man, Vol. 12, No. 88, pp. 158-162, 1912. Also in 37^e Bulletin de la Société Jersiaise, pp. 213-222, 1912.

Marett, R. R., Pleistocene Man in Jersey. Archæologia, Vol. 62, pp. 449-480, Oxford, 1911.

Marett, R. R., Further Observations on Prehistoric Man in Jersey. Archæologia, Vol. 63, pp. 1-28, 1912.

Marett, R. R., and De Gruchy, G. F. B., Excavation of a Further Portion of La Cotte de St. Brelade. 38^e Bulletin de la Société Jersiaise, pp. 326-330, 1913.

[2] Keith, A., and Knowles, F. H. S., A Description of Teeth of Paleolithic Man from Jersey. Journ. Anat. Physiol., London, Vol. 46, pp. 12-27, 1911. Reprinted, with an additional note, in 37^e Bulletin de la Société Jersiaise, pp. 223-240, 1912. Abstract in Nature, Vol. 86, pp. 415-416, 1911.

The teeth are in an unexpectedly good state of preservation, only the terminal parts of the roots being broken away. Their color is dark brown, with grayish white somewhat chalky looking crowns. All show advanced degree of fossilization. The apices of the cusps were worn away in life and the finer architecture of the crown is as if faded, probably through corrosive action of the moisture in the deposits that enclosed the specimens.

Five of the teeth, namely, a second left premolar, a first right and a second left molar, and the right and left third molar, with a part of the root of left incisor, belong to the upper jaw, while seven are from the lower jaw, being respectively a canine, first and second premolar with second molar of the left side, and a second incisor with second and third molars of the right side. All are probably from the same set and their characteristics are such that the ancient man they represent must be ranked anthropologically as one of the most primitive yet discovered.

The illustration on plate 63 shows a reconstruction of the upper and lower dental arches of the St. Brelade man, by Keith and Knowles, and the upper arch in the modern human skull, after Cunningham. It is seen at a glance that the Jersey teeth are larger than the modern in every direction and that in consequence the dental arches themselves must have been considerably larger.

Another feature in which the Jersey teeth differ even more radically from the recent, is their extraordinarily stout roots. The diameters of the neck and roots of the Jersey teeth are almost equal to and in some cases exceed those of the crown, indicating that relatively great requirements were made on the teeth by the quality and possibly also quantity of the food. Such roots indicate unmistakably strong muscles of mastication and a stout massive lower jaw, probably somewhat smaller but scarcely less powerful than the still earlier Mauer mandible.

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[1] In June, 1912, the writer visited Jersey to examine the original teeth and to visit the cave where they were discovered, and he wishes warmly to thank Mr. Sinel and Dr. Dunlap for the courteous treatment and facilities which they extended to him on this occasion, as well as to Captain Rybot, of the 76th Punjabis, for his service in furnishing excellent sketches of the locality. In 1923 the writer revisited Jersey and the cave with Professor Marett, whose great courtesy is also hereby gratefully acknowledged.

The roots of the Jersey premolars and molars are not only stout but they are also to a large extent fused. This is not an anthropoid feature, for in the higher apes these roots are well apart. The fusion is due to great development of the dentine and cement of the roots, brought about in this early man, in the opinion of Keith and Knowles, by a changed manner of mastication, characterized by more lateral besides vertical movements of the lower jaw. Other primitive features of the teeth are the early filling of the pulp cavities by deposits of dentine, thus providing an early adaptation for wear; the size and characters of the first premolars, which contrary to what occurs in present man are larger than the second; and certain features of the canine as well as of the molars.

Without going into more details, for which the reader may consult the originals—it may safely be concluded that the Jersey teeth constitute another valuable document of man's ancestry; and that they show an early man, probably a representative of *Homo neanderthalensis,* already quite advanced in denture from the prehuman forms, but still with teeth more powerful as well as less specifically differentiated than those of present man.

In 1916, Professor Marett reports in detail on additional work in the La Cotte de St. Brelade and on the fauna and stone industry of the cave. Further explorations have been carried on in 1913, 1914 and 1915. A large part of the original cave was cleared. By the end of 1915, some 1,200 square feet of the paleolithic floor had been unearthed and thoroughly examined; and the upper part of the wall of the débris to the rear of the cave had been cut back to the distance of 50 feet from the entrance. Later, exploration was commenced also in the cave on the other side of the ravine.

The combined explorations to the end of 1915, resulted in the recovery of many thousands of stone implements and rejects, and also of numerous bones of Pleistocene animals; but there were no further important discoveries of skeletal remains of man. Outside of the cave, in the talus at the back of the ravine, there were found, regettably without scientific supervision, three pieces of a partly cremated child's skull. The largest portion is that of the left side of the occipital; according to Dr. Keith it belonged to a child not more than six years of age, and both inside and outside bears the marks of the modern rather than the Neanderthal type of man. This was therefore probably a later intrusive specimen.

The list of animal species from the cave comprises now the following:

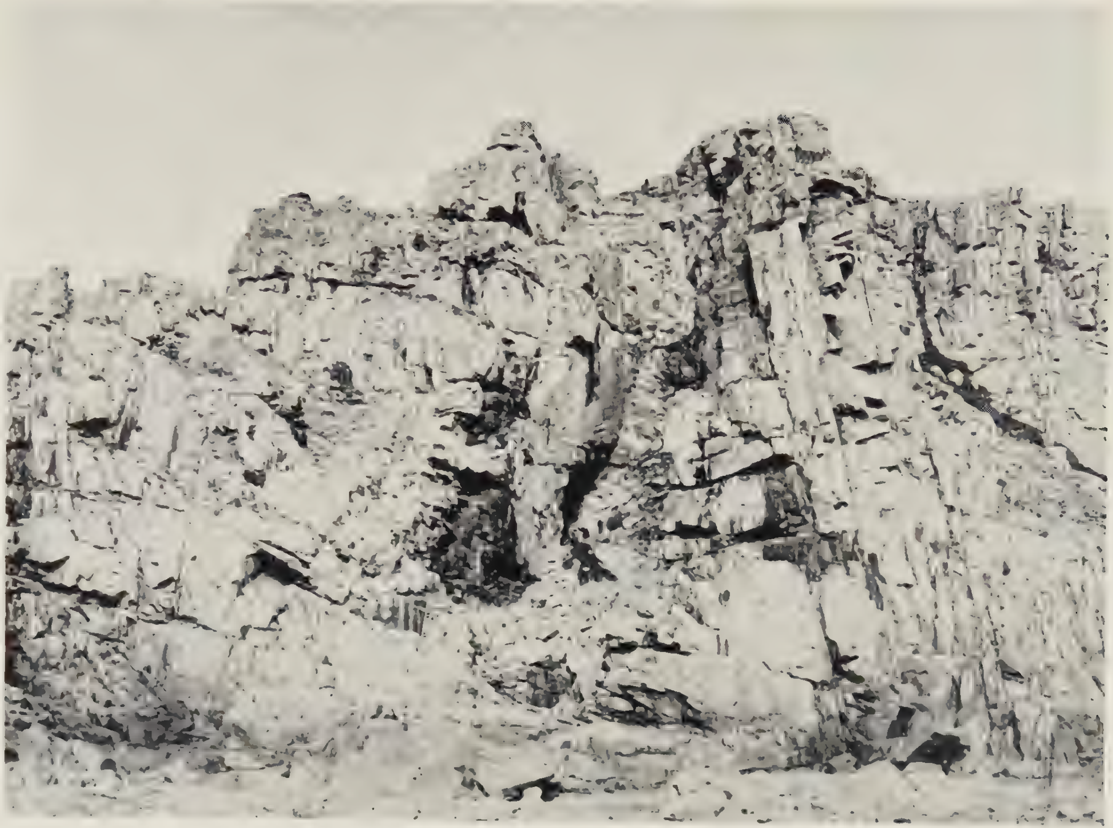
Elephas ?trogontherii
Elephas primigenius
Rhinoceros tichorhinus
Cervus megaceros
Cervus tarandus
Cervus elaphus
Cervus ?capreolus
Cervus sp.
Equus
Bos primigenius
Hyaena crocuta, var. *spelaea*
Canis ?lupus
Canis vulpes
Dicrostonyx torquatus
Microtus ratticeps
Arvicola sp.
Lepus ?cuniculus
Sorex araneus
Anser brachyrhynchus
Bernicla leucopsis
Bernicla brenta
Gallinula chloropus
Cinclus aquaticus
Tetrao sp.
?Lagopus mutus
Falco tinnunculus

In the case of the ox, horse, reindeer, and rabbit, considerable discrepancies occur in the size of the teeth and other bones, and it may well be that bison coexisted with the urus, Prjewalski's horse with the " forest horse," caribou with a smaller reindeer, and Arctic hare with the rabbit. The bones of all the species were in close association with implements of Mousterian pattern.

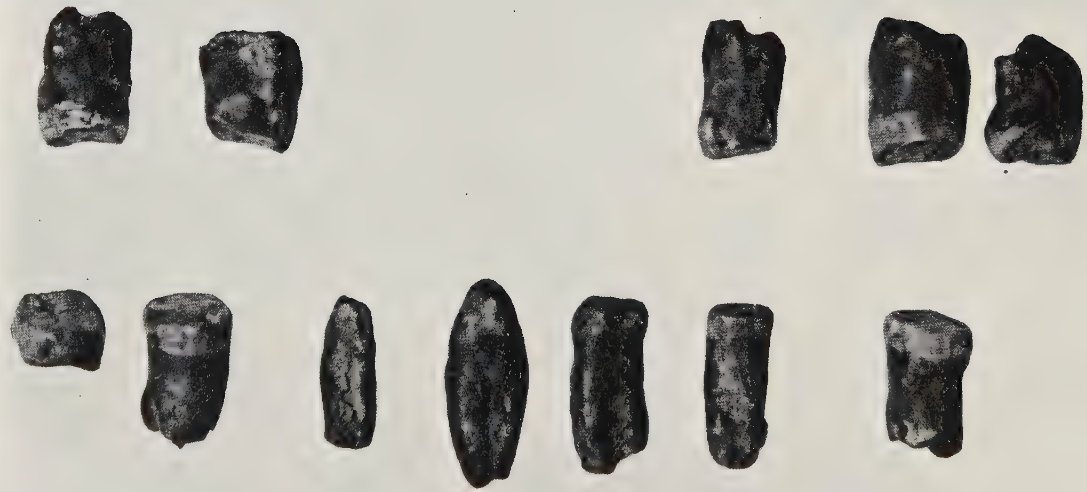
The stratigraphy was rather disappointing.

Among the artifacts there was a small flat piece of bone on which are to be seen a number of parallel double cuts of artificial, human origin. Several sharply pointed pieces of bone may have served as drills; but a convincing example of a bone implement has up to the end of 1915 not come to light. As to the flint industry, the total number of flints showing human work recovered from the cave to the end of 1915, was 15,070. Among these 155 were perfect specimens of Mousterian tools of first quality, showing the classic forms of this industry. Then came several thousands of rougher examples, of second and third quality; the remainder being waste of manufacture.

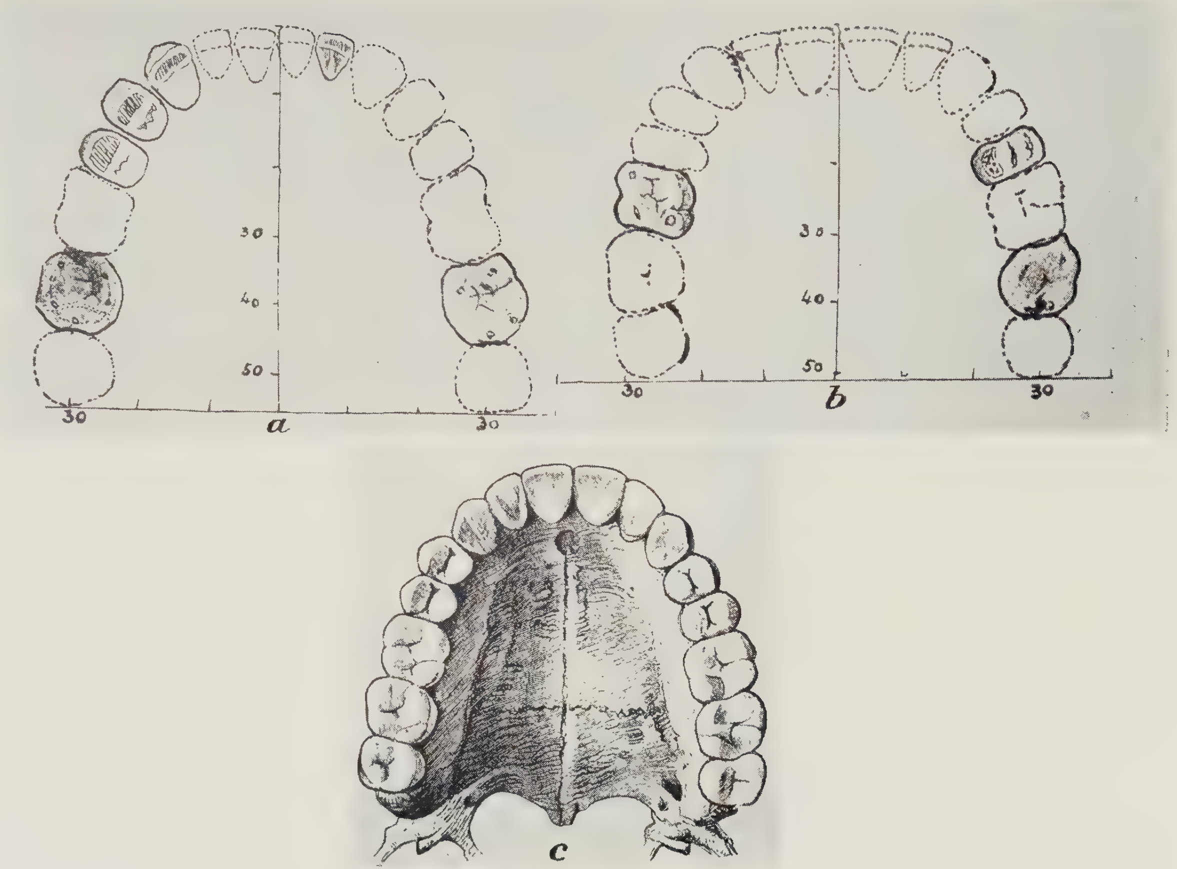
Marett inclined at this period to assign the industry of the cave to two periods, probably separated by a chronological hiatus. The industry of the first period he assigns to the Middle Mousterian. " It is, in fact, the typical industry of Le Moustier itself." The work of the upper bed on the other hand he assigns to the Upper Mousterian. It is not Aurignacian in his opinion, " but nevertheless foreshadows the Aurignacian industry in a number of ways. There are particular implements, though in no sense typical ones, that closely resemble Aurignacian forms as regards their outline; but the trimming is Mousterian, not Aurignacian, in its technique." The conclusion of



The Jersey cave. (Photograph by R. R. Marett.)



The Jersey teeth. (After Keith; from a photograph furnished to the Smithsonian Institution by Dr. R. R. Marett, of Oxford.)



a. Teeth of lower jaw of the Jersey man, placed in their probable positions, with reconstruction of lower alveolar arch. (After Keith.)

b. Teeth of the upper jaw of the Jersey man, in their probable positions, with reconstruction of the upper alveolar arch. (After Keith.)

c. Modern upper dental arch and teeth. (After Cunningham.)

Professor Marett, in 1916, is that "La Cotte de St. Brelade is entitled to rank as a pure Mousterian site, as rich and representative in its way as almost any in Europe."

ADDITIONAL LITERATURE

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——— and Nicolle, E. T. Report on the exploration of the palaeolithic cave-dwelling known as La Cotte, St. Brelade, Jersey. Bull. Soc. Jersiaise, Vol. 36, pp. 69-74, 1911.

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THE FOSSIL MAN OF LA CHAPELLE-AUX-SAINTS

One of the most interesting, best authenticated, and thanks to Marcellin Boule now best-known skeletons of early man, is that of "the fossil man of La Chapelle-Aux-Saints." La Chapelle-Aux-Saints is a small village in the Department of Corrèze, near the small railroad station of Vayrac, south of the town of Brive, in southern France. A little over 200 yards from the village and beyond the left bank of the small stream Sourdoire, in the side of a moderate elevation, is a cave, now known as that of La Chapelle-Aux-Saints (pl. 64). In 1905 archeological exploration of this cave was undertaken by three Corrèze priests, the Abbés A. and J. Bouyssonie and L. Bardon. These explorations which from the beginning were successful, resulting in the recovery of numerous industrial and other vestiges of paleolithic man, progressed gradually until the uniform archeological stratum was nearly exhausted, when, on August 3, 1908, in the floor of the cave, the excavators came across a shallow artificial fossa in which lay remnants of the bones of a remarkable human skeleton.

The human bones were carefully gathered and sent to Professor Boule, at the Muséum d'Histoire Naturelle, Paris, where they were cleaned and as far as possible restored; and the following December Professor Boule demonstrated the skull, giving at the same time the first account of the find, before the Paris Academy of Sciences.[1] One week later Messrs. Bouyssonie and Bardon presented before the Academy their own observations, and these reports were followed at short intervals by several others before the same scientific body.[2] Subsequently the skull and other parts of the skeleton were subjected by Professor Boule to a thorough study and comparison. The results

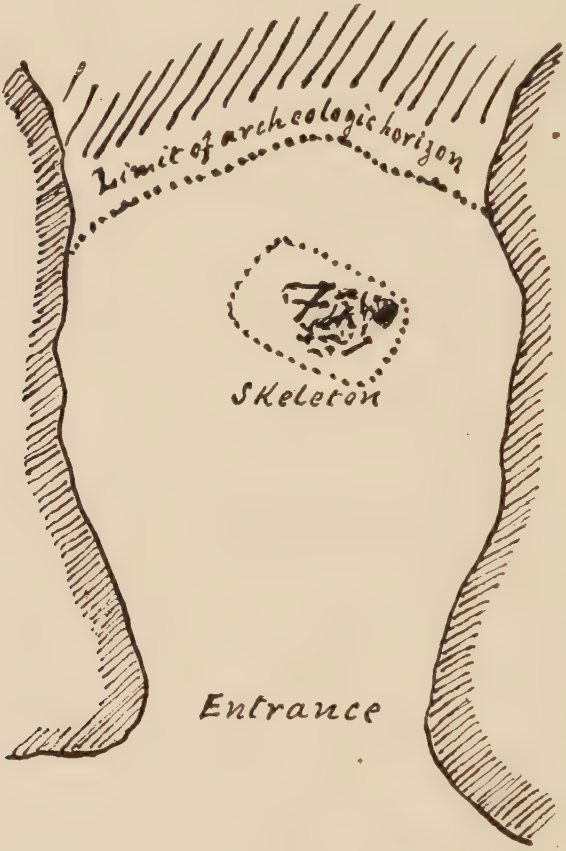

FIG. 22.—The interior of the La Chapelle cave.

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[1] Boule, M., L'Homme fossile de la Chapelle-Aux-Saints. C. R. Acad. Sci. Paris, Dec. 14, 1908. L'Anthropologie, Vol. 19, pp. 513-519, 1908; Vol. 20, p. 257, 1909; Vol. 22, p. 129, 1911.

[2] Bouyssonie, A. and J., and Bardon, L., Découverte d'un squelette humain moustérien à la bouffia de La Chapelle-Aux-Saints. C. R. Acad. Sci. Paris, Dec. 21, 1908. Boule, M., Sur la capacité cranienne des Hommes fossiles du type dit de Neanderthal. C. R. Acad. Sci. Paris, May 17, 1909; Le squelette du tronc et des membres de l'Homme fossile de La Chapelle-Aux-Saints. C. R. Acad. Sci. Paris, June 7, 1909.

of his work were published in a series of communications extending through the sixth, seventh and eighth volumes of the Annales de Paléontologie, and in 1913 they were issued in a large individual volume.[1]

These various reports show that the cave of La Chapelle-Aux-Saints is a moderate-sized and rather low cavity, about 6 m. (19 ft.) long, 2 to 4 m. (6 to 13 ft.) broad, and 1 to 1.50 m. (3 to 4.5 ft.) high (fig. 23). When first approached it was seen to be nearly filled with old accumulations, which later disclosed numerous traces of man, and with débris of the rock from the roof and sides.

The stratigraphy of the cave was found to be quite simple—there was but one fossiliferous layer, of Pleistocene age, posterior apparently to the excavation of the fossa that contained the skeleton (Boule, Mém., pp. 10-12). The worked flints and quartz gathered from this layer reached over 1,000 in number. They showed careful and able work. They comprised especially the two classical Mousterian types, points and scrapers, and their derivatives. There were also a few instruments of Acheulean type, and a number of well chipped blades as well as other forms that presaged the Aurignacian. There was no trace however of any worked bone.

The animal bones show generally signs of intentional breaking, for the marrow; some show also traces of fire or marks of implements. The following species were identified:

Rhinoceros tichorhinus
Hyaena crocuta
Rangifer tarandus
Capra ibex
Bison priscus
Canis lupus
Canis vulpes
Meles taxus
Equus caballus
Sus scrofa
Arctomys marmotta
Various birds.

This is a cold fauna, referable to the last glaciation.

Under the accumulations the floor of the cavern was found to be whitish, hard, marly calcareous; and in this hard base, at the distance of a little over four m. from the entrance of the cave, was found a nearly rectangular, moderate-sized cavity,[2] which lodged a fossil human skeleton. The depression, in the opinion of the explorers, had clearly been made by the primitive inhabitants or visitors of the cave, representing a regular burial, one of the most ancient intentional burials thus far discovered.

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[1] Paris, 1911 to 1913. Also published as a separate volume, 278 pp., numerous pls. and figs., Paris, 1913. For brevity this volume will be referred to henceforth as the "Mém."

[2] 1.45 m. long, 1 m. broad, and 30 cm. deep.

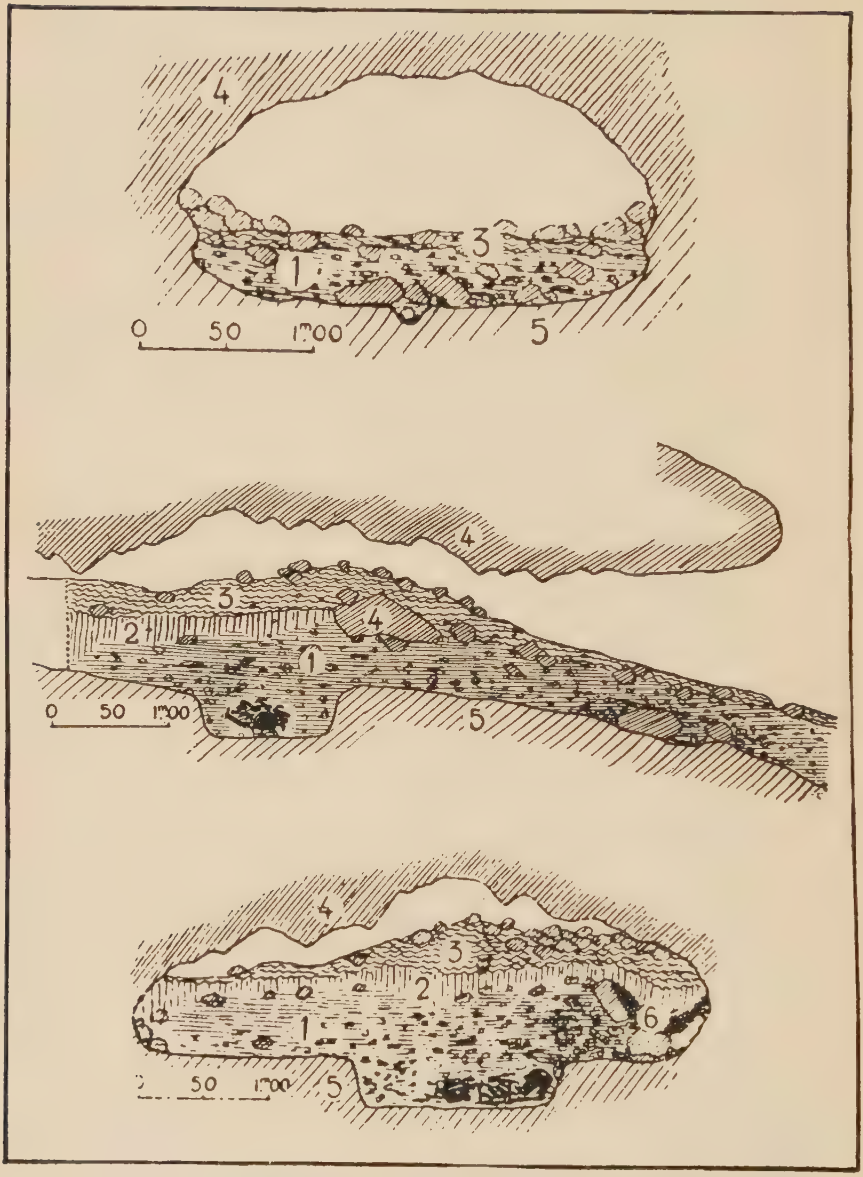
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FIG. 23.—The La Chapelle cave, transversely at entrance (upper), longitudinally (middle), and transversely at the skeleton fossa (lower). (After Boule.)

The body lay apparently on its back, with the head to the westward. The head reposed against the wall of the fossa in one corner, and was surrounded by stones. The left arm was extended, the right probably bent so that the hand was applied to or lay near the head. The lower limbs were flexed. Above the head were found three or four large flat fragments of long bones of animals, and somewhat higher there lay, still in their natural relation, the foot bones of a large bovid, suggesting that the whole foot of the animal may have been placed in that position, perhaps as an offering to the dead. About the body in the fossa were numerous flakes of quartz and flint, some fragments of ochre, broken animal bones, etc., much as in the rest of the archeological stratum above the skeleton. To the right of the fossa containing the skeleton were many large fragments of various animal bones, jaws and vertebrae of the reindeer, and vertebrae of a large bovid, with some very well made implements of flint. The last-named vertebrae and the flint implements were covered by two large slabs of stone; and above these slabs, at the side wall of the cave, the earth showed the effects of fire; but it was not possible to determine whether this was of the same date as the deposits or the human burial beneath. There was no indication that the deposits in the cave had been moved in any way since the burial of the human body.

On taking out the human bones it was found that, through decay or other causes, many were defective, and some parts of the human skeleton were lost. What remained comprises the skull, almost complete, with the lower jaw; 21 vertebrae or pieces of same; 20 ribs or their fragments; an incomplete left clavicle; the two humeri, almost complete; the two radii and the two ulnae, all more or less defective; a few bones of the hands and feet; portions of the pelvic bones, fragments of the right femur (from which it is possible to reconstruct the bone) and the lower half of the left femur; the two patellae, and parts of the tibiae. The state of preservation of the specimens is exactly like that of the animal bones recovered from the deposits about the burial fossa. They are ferruginous in color, heavier than any corresponding recent human bones and very perceptibly mineralized.

Through the kindness of Prof. Boule the writer was enabled in 1912 and again in 1923 and 1927 to see the originals of the Chapelle-aux-Saints skeleton. It was not possible to undertake any personal detailed study on the bones, but even brief examinations were sufficient to impress one deeply, particularly in the case of the skull, with the great scientific value of the remains. They represent another precious addition to the rapidly augmenting material evidence of the highly interesting type of ancient man, *Homo neanderthalensis.*

With the excellent and well-illustrated reports of Professor Boule, with a good plaster model of the skull, and with the writer's observations on the originals, it is possible to give the following notes on these specimens. The illustrations are all after Boule.

THE SKULL

The La Chapelle skull, notwithstanding its many peculiarities, is plainly a normal specimen, not affected (except in the dental arches) by any disease or by any premature closure of sutures (pls. 65, 66), and with but moderate injuries. The skull, except for the sexual differences, comes close in many respects to that of Gibraltar. It is also closely related to that of Neanderthal; but, except for the vault of No. 1, it is distinctly more primitive than the Spy crania, particularly in its facial portions and the lower jaw. The characteristics that strike one most forcibly at first sight about the La Chapelle specimen are the lowness and the large size, especially in length, of the vault; the huge supraorbital arch; primitive features of the face; and a large and primitive lower jaw. More in detail the skull presents the following features:

The vault.—The vault is of the same type as that of the Neanderthal skull, being only somewhat longer and more spacious. There are the same heavy semilunar supraorbital welts or arches meeting in a shallow depression at the glabella, which is carried far forward. The arches are about as heavy and thick as in the Neanderthal, and show but a very slight tendency towards diminution in thickness from the middle of the upper orbital borders outward. In the median line the arches descend united down the stout nasal process of the frontal. Above the supraorbital arches there is much the same depression as in the Neanderthal skull; but the forehead of the La Chapelle skull, while about equally as broad as that in the Neanderthal, shows slightly greater height and fullness. The sagittal region is quite smooth and oval from side to side. The parietal eminences are situated low from above downward and far back as in the Neanderthal and the Spy No. 1. The occiput, somewhat more protruding on the right, is typically Neanderthal—broad from side to side and flattened both above and below. Its protrusion is rather marked when the skull is viewed from the side. There is a strong superior nuchal torus, but it does not extend downward and forward.

The outline of the vault when viewed from above is a prolonged ovoid, mildly asymmetric in its posterior portion, due to the slightly greater size and potrusion backwards of the right side. The temporal squamae are low, the temporal fossae large, the zygomae very stout.

The temporal ridges (lines) above are not strongly marked and do not approach close to the sagittal suture. The mastoids are remarkably moderate for a male skull and one of this size, approaching in this respect the earlier primate forms. The digastric groove beneath is broad, as in other Neanderthalers. The bones of the vault, seen well through a large defect in the upper part of the left parietal, are not as thick as in the Neanderthal skull, but are about one-fifth stouter than they are in average white male skulls of today; the parietal measures 6 to 8 mm., the frontal squama 8 mm.

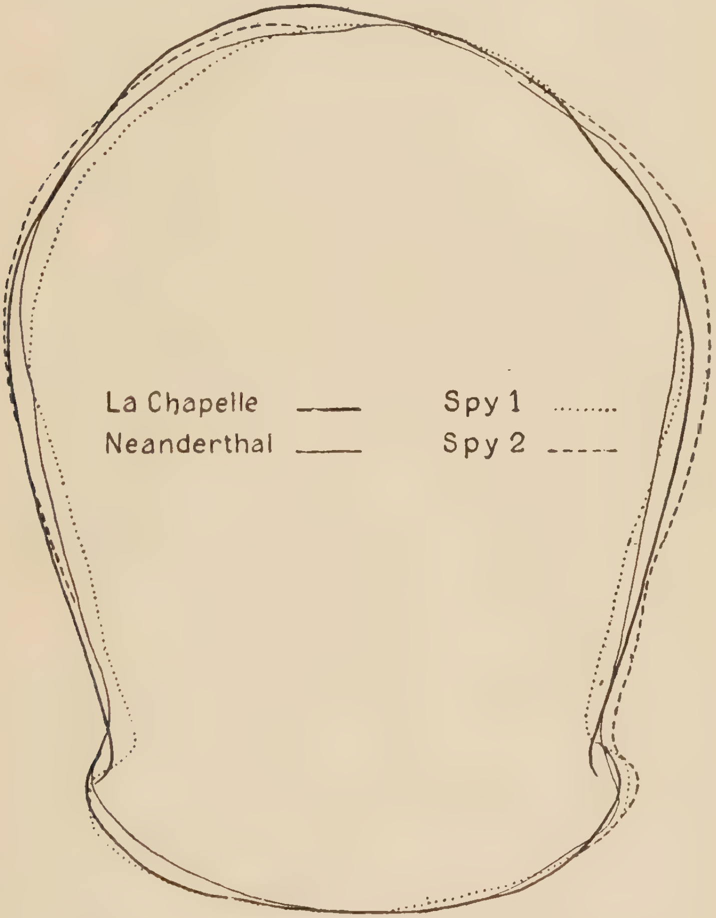

FIG. 24.—The La Chapelle skull, and comparison of the outline of its norma superior with that of other Neanderthal skulls. (After Boule.)

The base.—The base is considerably damaged. It was evidently rather flat. The foramen magnum is large, situated relatively slightly more backward than in modern skulls, and shows less inclination. The condyles are small and low. The stout pterygoid processes ran upwards and backwards, more obliquely than in recent skulls. The temporal-basal parts are all stout. There were no styloids. The glenoid region on each side is massive and large. The glenoid fossae are somewhat shallow but broad laterally, and their shape is such that their cast, especially on the right, would present a well marked lateral ridge along the summit; in other words, their cross section antero-posteriorly would approach somewhat more the **V**-shape than the **U**-shape that is generally seen in modern crania. Between the tympanic plate and the mastoid on each side is a groove approximately 7 mm. broad, much as in the Gibraltar skull; crania of today show only occasional traces of such a groove.

The face.—The orbits are large, though relative to the size of the face and skull not as large as in the Gibraltar specimen; and they are roughly rounded. The borders are very dull superiorly and mesially, better defined inferiorly. Due to the pronounced supraorbital arch the upper half of the orbits, as in the Neanderthal skull, has a somewhat forward and downward inclination, unlike that of any man of today. Laterally, moreover, their plane slopes very perceptibly outwards and backwards, as in the Gibraltar. The mid-portion of the face from the nasion downward is markedly stouter, fuller, and more protruding forward than it is in modern skulls—much as in the Gibraltar cranium. There are no suborbital (canine) fossae, the surface of the maxillae in this region being perceptibly convex, instead of concave—again as in the Gibraltar. The nasal aperture is very broad—once more as in the Gibraltar. The nasal spine is moderately developed, especially on the right. The lower nasal borders are fairly sharp. On the left in the rear of the border is seen a groove, followed by a moderate dull ridge, running from the base of the spine upward and slightly backward to above the middle of the lateral wall of the aperture. All the facial bones are stronger than they are in modern skulls. The body of the malars was relatively small, especially for a male, but the nasal and zygomatic processes are broad and stout. There was no protrusion forward of the malars and the plane of their surface sloped backward more than in any modern crania. This is distinctly a simian feature. Here again there are close resemblances to the Gibraltar. The upper alveolar process (and also the lower) has suffered considerably from absorption after a loss of most of the teeth, probably due to old age. It was not especially high or especially sloping forward (alveolar prognathism), but the whole region was carried more forward than in more recent skulls, giving greater facial prognathism (see measurements). This was due plainly to the large development of the dental arches, teeth, and the jaws. The upper dental arch and palate are very large. The palate is **U**-shaped and of about medium depth; there is no torus.

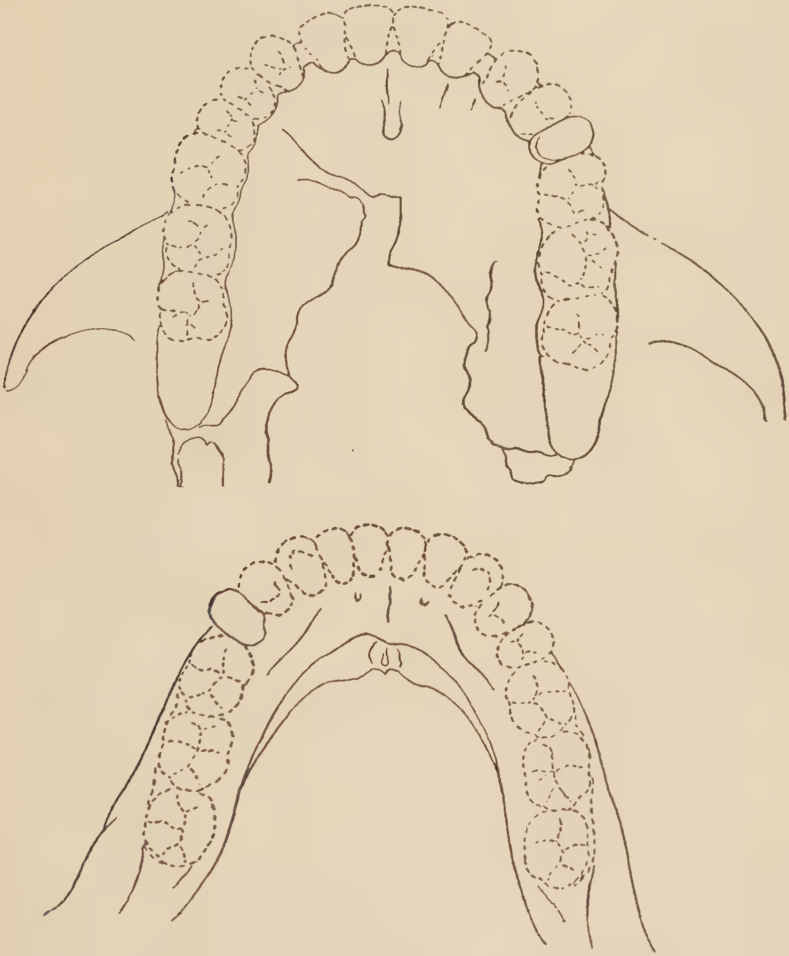

FIG. 25.—Upper and lower dental arches of the La Chapelle skull, as reconstructed by Boule.

The teeth.—Of the teeth there remain only a left upper and left lower premolar, and both of them much worn. The lower premolar, with but a remnant of the enamel, shows an opening of the pulp cavity, and a very oblique wear sloping toward the lingual border. There is no mark of decay and the teeth were lost most probably through infection following the exposure, through wear, of the pulp cavities; there are traces of root abscesses.

The lower jaw.—The lower jaw is large antero-posteriorly, and also laterally. There is no chin and the symphyseal line was slightly negative (receding). The body was about as high and stout as in the most developed jaws of today. The rami are of about medium breadth for a jaw of this size; they are broader than the rami in most modern jaws but do not reach the proportions of those in some Eskimo and in the Mauer mandible. The upper third of the rami shows a perceptible eversion on the right side, which may, however, be postmortem. The condyles as seen from that on the right were short and stout.

Inferiorly, in its anterior portion, the jaw is slightly arched, and presents a bilateral, nearly flat surface for the insertion of the digastric muscles. There is a trace of an internal shelf in the form of a moderate swelling between the lingual border of the anterior portion of the jaw and the genial tubercles. The genial tubercles are rather small and much as they are in some modern jaws. Above them and on each side is a marked hollow, only rarely present in modern jaws; and above this hollow the bone rises in mild convexity to the border of the stout alveolar process.

The mylohyoid ridges are not excessive; but above and in front of them, in the premolar region, there are present lingually on the surface of the bone moderate swellings such as observed in the Mauer jaw and frequently in strong modern mandibles. The rami show several interesting exceptional features, the most striking of which is a defect of the angles. From about its middle the posterior border curves (on right) or bends (on left) downwards and forwards. The resulting form of the angle region approaches, especially on the left, that in the anthropoids.

The second peculiarity is the presence, on the external surface of each ramus, proceeding from the outer end of the condyle downwards, of a dull, fairly broad ridge, which looks like a supporting pillar or root of the condyle. It is clearly a reinforcement feature, of mechanical origin, due to the heavy stresses on the condyle. It is better marked on the left than on the right ramus; and between it and the anterior border of the ramus is a marked broad parallel depression. Nothing of this sort exists in simian jaws.

Other reinforcing ridges, with consequent fossae, are seen on the internal surface of the rami, and here the conditions approach decidedly those in the lower jaws of the large anthropoid apes. A pronounced ridge runs downward from the coronoid process, and another runs downward and forward from the inner end of the condyle. These two meet in a plain **V** in front of the neural foramen, midway between this and the anterior border of the ramus, where they form a pronounced single elevation that runs downward and forward to merge with the mylohyoid ridge. These several ridges leave in front, within the **V**, and especially behind the latter, marked hollows. All these features may be found represented more or less in the jaws of present man; but jointly and so highly developed, they occur only in the large anthropoid apes. The sigmoid notch is shallow, though less so than in the Mauer jaw.

CONCLUDING COMMENTS ON THE SKULL

The La Chapelle skull, as a whole, is plainly one of the more typical representatives of Neanderthal man. Its closest relations, particularly

MEASUREMENTS OF THE SKULL OF LA CHAPELLE-AUX-SAINTS

	Boule	Hrdlička
	cm.	*cm.*
Length max. from glabella	20.8	....
from ophryon	....	close to 19.8
Breadth max.	15.6	....
Cranial index with length max.	*75.0*	....
with length from ophryon	....	*78.8*
Basion-bregma height	13.1	....
Mean height index $\left(\frac{\text{bas.-bg. height} \times 100}{\text{mean of length plus breadth}}\right)$	....	*72.0*
Breadth-height index	*83.9*	*84.0*
Calottal index of Schwalbe	*40.5*[1]	....
Diam. frontal min.	10.9	....
Diam. frontal max.	12.2	....
Breadth max. of supraorbital arch	12.4	....
Index $\left(\frac{\text{d. f. min.} \times 100}{\text{d. f. max.}}\right)$	*89.3*	....
Face: Total height (menton-nasion)	approx. 13.1	....
Height, alveolar point-nasion	8.6	....
Diam. bizygomatic max.	15.3	....
Upper facial index	*56.2*	....
Facial angle (angle formed by lines basion-alveolar point and alveolar point-nasion)	62°	63°
Alveolar angle (angle formed by lines basion-alveolar-point and alveolar point-subnasal point)[2]	....	55
Upper dental arch: Length max.	7.0	....
Breadth max.	7.1[3]	near 7.4
Index $\left(\frac{\text{L} \times 100}{\text{B}}\right)$	*98.6*	near *94.6*

MEASUREMENTS OF THE SKULL OF LA CHAPELLE-AUX-SAINTS (CONTINUED)

Orbits: Breadth right	4.75	....
left	4.65	....
Height right	3.90	....
left	3.80	....
Index, mean	*81.9*	....
Nose: Length (nasion-spine)	6.1[4]	....
Length (nasion-lowest points of inferior border of aperture, each side)	....	6.4
Breadth	3.4	....
Index	*55.7*	*53.1*

[1] $\frac{\text{Max.-vertical height from the glabella-inion line} \times 100}{\text{Length of the glabella-inion line.}}$. Same index in the Pithecanthropus is 34.2; in the Gibraltar skull, 40.0; in the Neanderthal 40.4; in Spy No. 1, 40.9; and in Spy No. 2, 44.3 cm. (Boule, Mém., p. 36.)

[2] Lowest point on the inferior border of the left nasal notch.

[3] Owing to borders damaged or wanting, not enough allowance made; maximum original breadth was greater.

[4] Evidently not taken to base of spine, which corresponds to the middle of a line connecting the lowest points of the border of the aperture on each side.

LOWER JAW

	cm.	*cm.*
Height of body at mental foramen (in rear of post. premolar)	3.2	....
Thickness of body at same vertical	1.6	....
Thickness max.	....	was probably not over 1.7
Symphyseal angle (angle formed by the line of the symphysis and that of the inferior border of the jaw)	104°[1]	....
Mandibular angle	110°	....
Lateral diam. of right condyle	2.9	....
Antero-post. diam. of right condyle	1.35	....
Minimum breadth of ascending ramus, right	....	4.65
left	....	4.65
Height of right ramus, near	....	6.7
Height of left ramus, near	....	6.3
Length of corpus, approx., right	....	12.4
Length of corpus, approx., left	....	12.0

[1] In man of today this angle varies approximately from 57° to 93°; in early human mandibles from 85° to 110°; in anthropoid apes from 105° to 124° (Boule, Mém. p. 83).

in the facial portion, are with the skull of Gibraltar. It approaches in many essentials the human skull of today; yet it carries still many remnants of the prehuman past. As will be seen later, it belonged to a male of short stature but very muscular, massive frame, which doubtless accounts in great measure for its large brain.

THE BONES OF THE SKELETON

In the study of the bones of the skeleton of La Chapelle the student is seriously handicapped, on one hand, by the more or less defective state of the remains, and on the other, by a lack of casts, with the inability to use the originals. It is true that an excellent and detailed description of the remains is given by the one in whose charge they have been placed, Prof. Marcellin Boule; but even he does not give some of the important measurements, such for instance as the diameters at the middle of the shaft of the long bones, while in other cases he merges the measurements with those of other Neanderthal skeletons so that they lose their individuality. Thanks to Professor Boule the writer has been able to look over the originals, though not to take any measurements. The lack of the casts is a most serious disadvantage, and it is in the interests of human prehistory that it be soon remedied.

The following notes on the skeletal parts are largely after Professor Boule.[1]

The different parts of the skeleton are substantially related to those of other Neanderthal remains, more particular to those of the skeletons Neanderthal, Spy No. 2 and the male La Ferrassie.

The vertebrae.—The vertebral column of the man of La Chapelle was short and stocky. All the vertebrae that remain are remarkable for the low height of their bodies. Many of the vertebrae show some senile marginal exostoses. The three cervical vertebrae with the uppermost dorsal are remarkable for their nearly horizontal spines, which is a simian character seldom approached in man of today. The dorsal and lumbar vertebrae—all that remains of them—are marked by the relative lowness of their bodies, and by various minor peculiarities. In the lumbar region the vertebral canal is considerably larger, relatively, than it is in present man. The articular facets of the transverse processes of the lumbar vertebrae, particularly in the case of the first, are relatively large and flat. A portion of the first sacral vertebra shows a large neural canal. Judging from what remains of the sacrum the bone was rather narrow and straight.

The ribs.—The ribs are stout and their cross section is triangular and not flattened as it is in modern skeletons. This form indicates the existence of powerful intercostal muscles. The curvatures of the ribs, where shown, are less pronounced than in corresponding ribs of the present time.

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[1] Mém., p. 106 *et seq.*

The clavicles.—Present, approximately the distal half of the left bone. It is seen that the clavicle was relatively long, but of only moderate strength. This agrees with the characteristics of the clavicle in all the other known Neanderthal remains where more or less of the bone is preserved. It indicates a very broad chest.

The humeri.—The right humerus is but little damaged, lacking a small part of the head; in the left humerus the head is largely deficient. The right bone is notably stronger than the left, indicating strongly developed right handedness, which is essentially a human character. The humeri were relatively stout and short, their extremities voluminous. All the muscular insertions are strongly marked. The strength of the right bone exceeds slightly that of even the strongest bones of today. The torsion of the humerus falls within the present range of variation of this character. The shaft is remarkably straight and cylindrical, resembling in this respect more the humeri of the large anthropoids than those of present man. The distal extremity of the humerus is large, and presents various details of interest. The large fossa is not perforated. All the characters denote a strong development of the muscles. The left humerus differs from the right only by its greater slenderness. On the whole the morphology of the humeri of La Chapelle is very human.

Bones of the forearm.—All of the bones are present but not complete. They are remarkable for the grossness of their extremities, the strength of the muscular impressions, and the pronounced curvatures of the shaft.

The radii.—The right radius is distinctly stronger than the left, though the difference is less marked than that between the humeri of the two sides.

The ulnae.—The right ulna is but slightly stronger than the left. The shafts of the ulnae are very straight and much less prismatic than in present man. An outline of the shaft at the middle is nearly elliptic, approaching thus the shape of the bone in the anthropoid apes. The upper part of the shaft is extraordinarily flattened antero-posteriorly. The head and the olecranon process are stouter in all respects than in modern man. The coronoid process is more horizontal than usual today. The articular facets are less excavated. On the whole both the radius and the ulna of the La Chapelle skeleton, in common with the forearm bones of other Neanderthal skeletons, show a number of inferior ancestral characters, and differ correspondingly from the same bones in modern man.

Bones of the hands.—The metacarpals are unusually long and stout, with very strong articular extremities. The hands of the fossil man of La Chapelle were decidedly large and strong; but the thumb appears to have been relatively shorter than at present. The articular facets of the bones that are preserved show some interesting peculiarities not generally present in man of today.

The pelvis.—The very incomplete pelvis is long (*i. e.,* high) in relation to its breadth; but in general, as far as it can be judged from the bones present, it presented proportions and form similar to those of the pelves of modern man, especially those in which the sacrum is narrow. The bones were robust, massive. The ilia were rather flat. The great sciatic notch is deep and narrow. As far as represented, the pelvic bones of the La Chapelle skeleton resemble exceedingly closely the pelvic bones of Neanderthal man.

The femora.—The femora are in pieces. Carefully reconstructed by Boule, they show in all their characteristics close relation to the Neanderthal and Spy femora. The bones are stout, the extremities are large. The right and the left bones differ but slightly in strength. The shafts show uniform curvature forward, even a trace stronger apparently than that of the Neanderthal and Spy femora. The linea aspera is somewhat more marked than in Neanderthal and Spy. Platymery is wanting. Of the lower extremities of the femora there are but fragments, on which definite observations are difficult; but what remains indicates the same characteristics of this part of the bone as exist in the Neanderthal and the Spy femora.

The patellae.—The two patellae of La Chapelle are well preserved.

The right bone measures 4.6 in breadth, 3.9 in height, and 2.1 cm. in thickness. The bone is somewhat smaller than those of Spy No. 2 and those of Krapina.

The tibiae.—The tibiae are very incomplete. They were relatively short and strong, and were not platycnemic, closely resembling those of Spy. The extremities were voluminous. The upper end shows a more marked retroversion backward than is present in the modern tibiae. The shaft shows but a slight lateral curvature in its upper third.

The fibulae.—Present, the upper half of the shaft of the right bone. It is remarkable for its stoutness, and for its sub-cylindrical form which differs from those of modern bones.

The astragalus.—Present, the left bone only, somewhat damaged. It is relatively shorter, higher, and especially broader than the astragali of present man of all races. The shortness of the bone is especially due to the shortness of its neck. In detail the bone presents several primitive characters. It resembles in general the astragali, as far as known, of the other Neanderthal skeletons.

The calcaneus.—Present, the left bone, seriously damaged; reconstructed with care by M. Boule. The bone is relatively long, broad, as well as high. The length is due especially to the heel part. The sustentaculum is considerably developed. The articular surfaces of the bone present some primitive features. The ligamentous insertions and grooves are all strongly marked.

Bones of the feet.—These bones are very defective. The metatarsals were evidently relatively short but stout, with large extremities; that of the large toe was especially robust, more so than in the majority of human feet of today.

General considerations.—The general aspect of the body of the man of La Chapelle was somewhat different from that of recent man, the posture was less perfectly erect. The stature of the La Chapelle man, if estimated from the length of the humerus, may have been approximately 163 cm., which would be near the average of the Neanderthal males estimated in a similar manner. But Boule is of the opinion that in view of the short spine and short tibia this estimate is much too high, and that the stature in life of the La Chapelle male was more probably about 155 cm. (Mém., 116-118.)

DIMENSIONS OF THE SKELETAL PARTS OF THE LA CHAPELLE MAN

(Abstracted from Boule)

Estimated stature in life.................................... 155–163 cm.

	cm. r.	cm. l.
Humerus: Length max.........................	31.3	....
Minimum circumference of shaft...............	7.2	....
Angle of torsion..........................	148°[1]	....
Humero-femoral index.......................	near *70.3*	....
Tibiae: Length, in position and without spine, estimated..............................	....	34.0
Astragalus: Length[2].........................	....	5.7
Height..........................	....	3.5
Breadth.........................	....	5.3
Calcaneus: Length max., approx..................	....	8.0
Breadth...........................	....	4.7
B-L Index.........................	....	*58.0*

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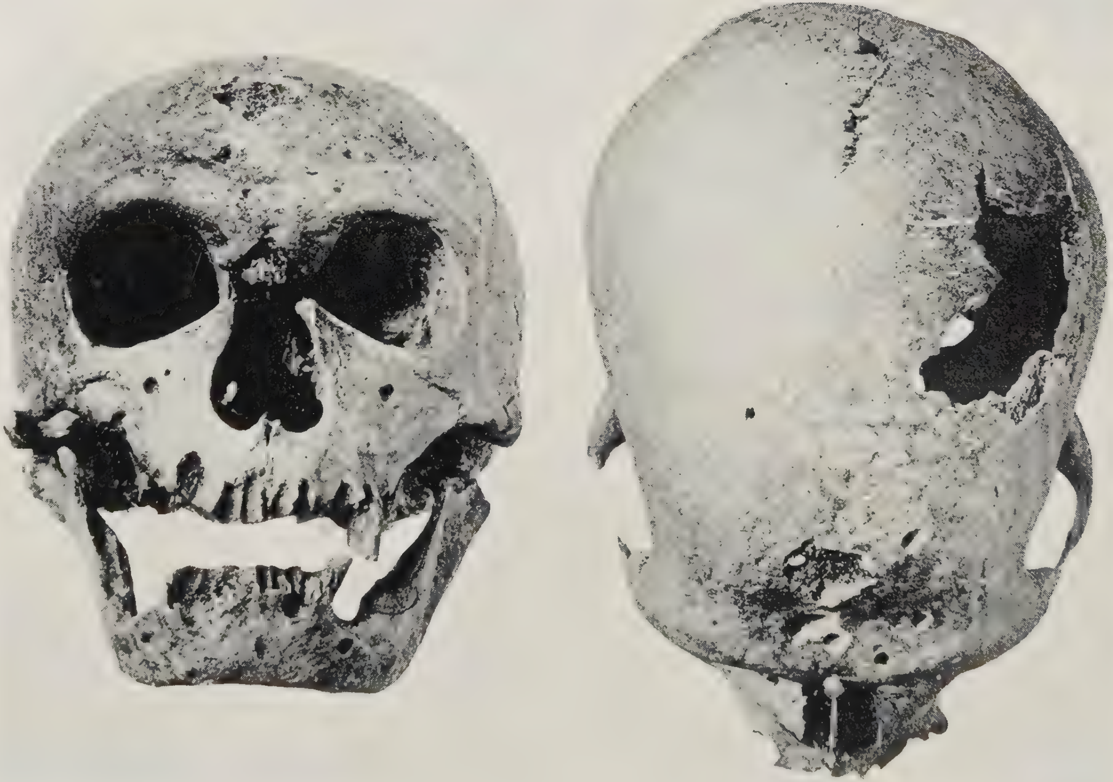
[1] In present man the average angle ranges from 134° to 162° (Boule, Mém., p. 125).

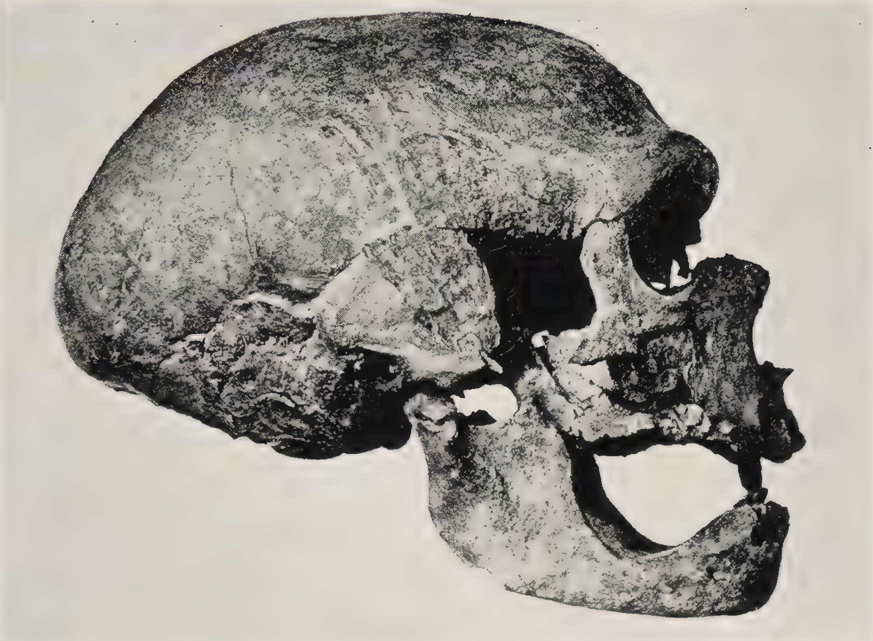
[2] Measurements by the method of Volkov, Les variations squeletiques du pied chez les Primates et dans les races humaines. Bull. et Mém. Soc. Anthrop., Paris, 1905.

1. The cave of La Chapelle-aux-Saints. (After Boule.)

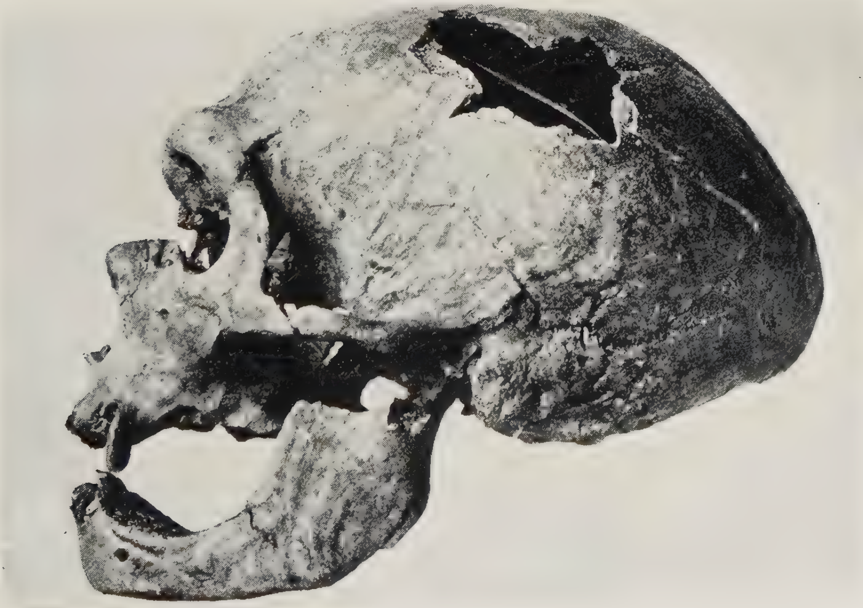
2. The interior of the cave of La Chapelle-aux-Saints, with the fossa that contained the skeleton in the right background.



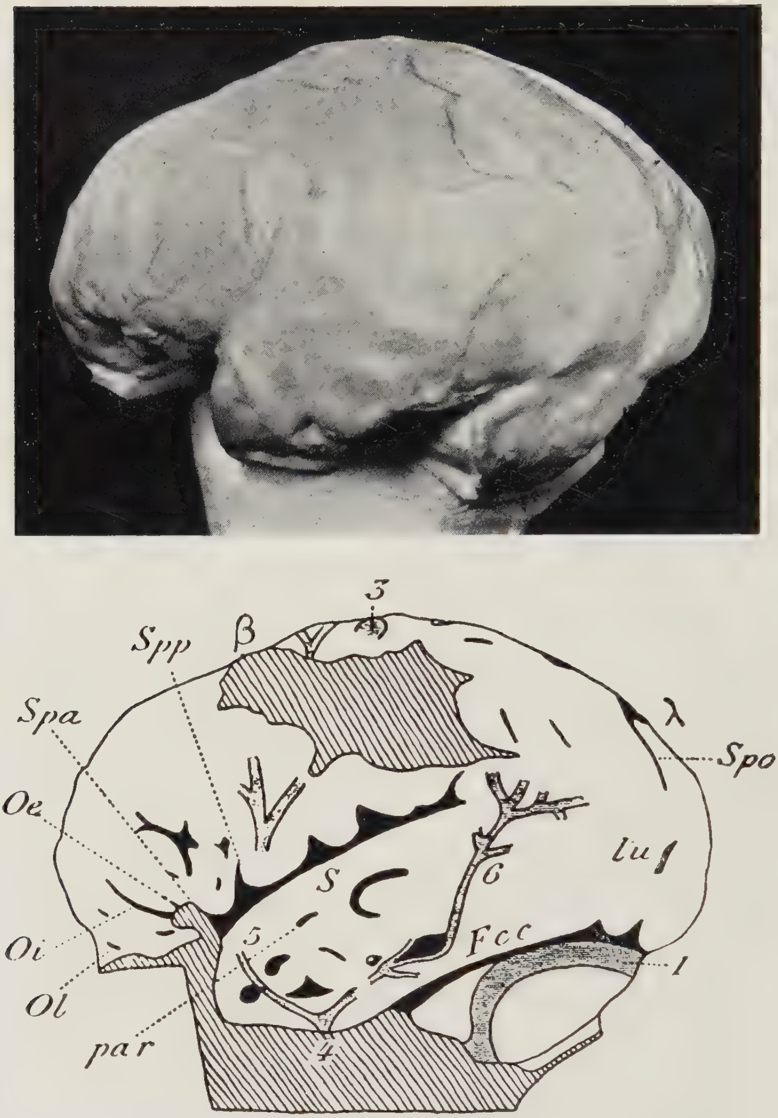
The La Chapelle skull. (After Boule.)



1. The La Chapelle skull, right side. (After Boule.)



2. The La Chapelle skull, left side. (After Boule.)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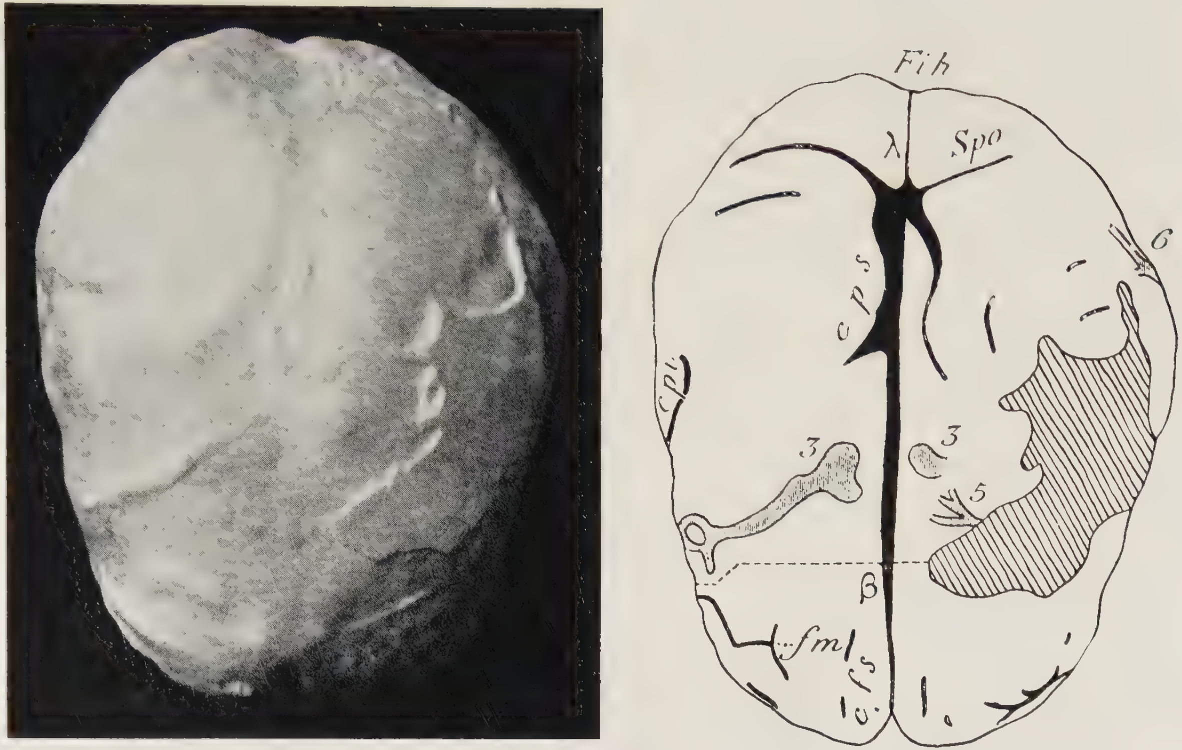
The endocranial cast of the La Chapelle skull. (After Boule.)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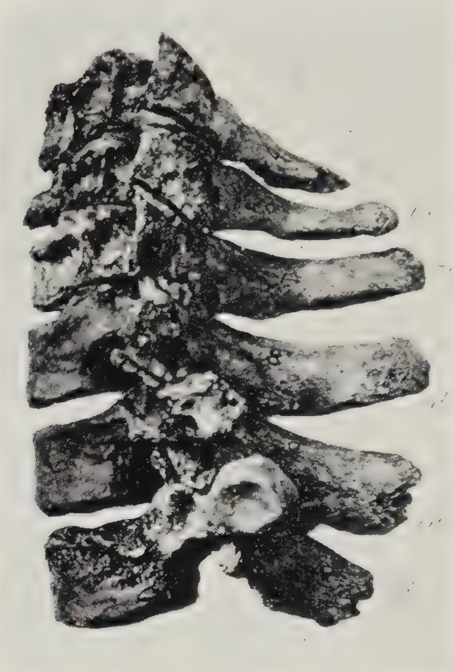
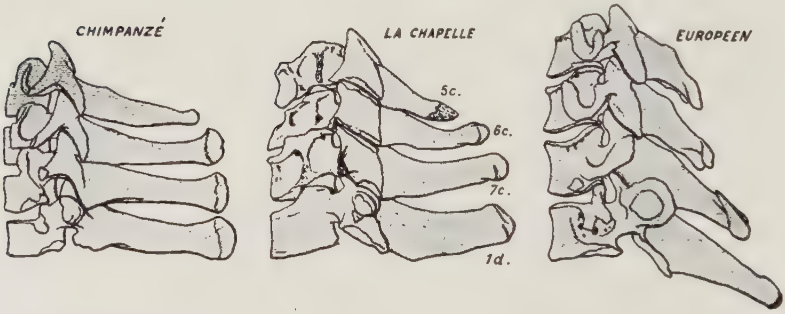
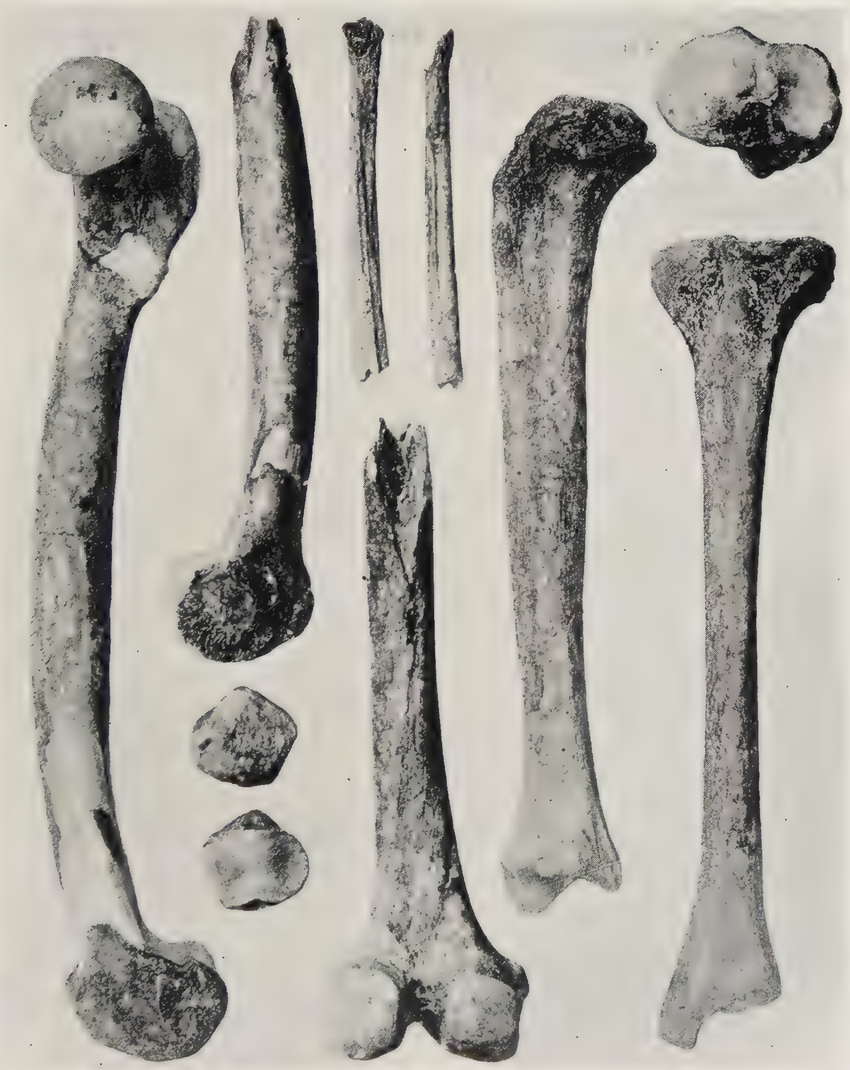
The endocranial cast of the La Chapelle skull, top view. (After Boule.)



1. The cervical and upper dorsal vertebrae of the La Chapelle skeleton.


CHIMPANZÉ
LA CHAPELLE
EUROPEEN
5c.
6c.
7c.
1d.

2. The same as figure 1, compared with the same vertebrae of a Chimpanzee and a modern European. Note the direction of the spinous processes. (After Boule.)



The La Chapelle skeleton; bones of the lower extremity. (After Boule.)

THE BRAIN

The cranial capacity of the skull is calculated by Professor Boule at 1,600-1,626 cc., which is above that of the other Neanderthal crania and also above the average man of today. A cast of the endocranial cavity of the La Chapelle skull shows a large brain, but low. In general the brain was quite human, but showed numerous primitive features.

The morphologic characteristics of the brain of the man of La Chapelle-aux-Saints are summarized thus by Boule and Anthony:[1]

1. Characteristics distinctly human: Large absolute volume; predominance of the left hemisphere; the presence of two presylvian branches, and of a human system of opercula.

2. Characteristics of simian nature, or intermediary between those of the anthropoids and man. These are the more numerous and comprise the general form; the general simplicity and gross aspect of the convolutions; the position and direction of the sylvian and rolandic fissures; the differentiation and length of the parieto-occipital fissure; the reduction of the frontal lobes, especially in their anterior region; the accentuation of the frontal beak or keel; the primitive character of the third frontal convolution which was probably devoid of the basal part; the presence of a much developed *sulcus lunatus;* the spread apart of the cerebellar hemispheres; the width and exposition of the vermis; and the direction of the medulla oblongata.

" On the whole the brain of the fossil man of La Chapelle-aux Saints is already a human brain by the abundance of its cerebral matter. But this matter still lacks the higher organization which characterizes that of present man."

The writer feels that inferior characteristics of the brain may by the above statements be somewhat overemphasized, and that most if not all of them could individually be duplicated in the more primitive brains of today. Nevertheless it is clear that while the brain of the La Chapelle man was large its differentiation was not highly advanced, and the all-important proportion of gray and white matter may have been quite different.

THE REMAINS OF LA FERRASSIE

" La Ferrassie " is the name of a rock-shelter close to a hamlet of that name, near Bugue, Dordogne, France. The locality belongs to the general region of the Vezère and Les Eyzies. In this rather exposed rock-shelter M. Peyrony with some associates discovered in September, 1909, a human skeleton of Neanderthal affinities. The discovery was announced before the Academie des Inscriptions, Nov. 10, 1909, and was shortly afterward published in the Revue de l'École d'Anthropologie.[1]

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[1] L'Anthropologie, Paris, Vol. 22, No. 2, p. 196, 1911; see also Boule's Mémoir.

M. Peyrony had been exploring the rock-shelter with its prehistoric deposits for ten years. The excavations showed that the spacious shelter had been inhabited for a very long time by successive prehistoric populations, and that each group of these left behind a layer of its kitchen refuse with its special stone industry. From its top to the base it was possible to identify the following horizons:

1. Upper Aurignacian;
2. Middle Aurignacian;
3. Lower Aurignacian;
4. Mousterian;
5. Acheulian.

After the middle Aurignacian the roof of the shelter fell down, and between and on the rocks accumulated the débris of the upper Aurignacians. Above this was a layer of over 12 feet of humus and gravel, to the surface.

The first skeleton was discovered by M. Peyrony in the lower part of the Mousterian deposits. The explorer, with Professor Capitan and another companion, removed just enough of the bones to satisfy themselves that they were human and then notified Professors Boule, Cartailhac and Breuil, with several more local prehistorians, of the find; and it was in the presence of these, on September 27, that the skeleton was carefully uncovered and disengaged from its deposits. The deposits and the condition of the skeleton *in situ,* when cleaned, are shown in plate 72.

The several cultural layers of the shelter were easily distinguished at sight, owing to their different coloration, and definitely so by their fauna and industry. The Mousterian layer, besides its characteristic stone industry, yielded an abundance of the bones of the bison, the stag, and the horse, with occasional parts of other later Quaternary animals.

As the explorers removed the upper layers and most of the Mousterian deposit, they found three flat stones, placed one above the skull, the two others over the shoulders or chest of the skeleton. Over the whole space enclosing the skeleton the deposits contained a considerably larger number of large fragments of animal bones than were found elsewhere. A piece of a bone lying just above the skeleton shows a series of fine intentional gravings, reminding one of the graved bones of the Aurignacian layers. The accumulations about the skeleton contained also a large number of very well worked flints of the Mousterian type. Such flints were found above, about, and even beneath the skeleton, those beneath being mingled with flints showing Acheulian industry.

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[1] Capitan and Peyrony, Deux squelettes humains au milieu de foyers de l'époque moustérienne. Rev. Écol. Anthrop. Paris, Vol. 19, pp. 402-409, 1909.

The work uncovered a whole skeleton, in position, although numerous parts, particularly of the thorax and the spine, were destroyed by decay or damaged by the pressure of the superimposed deposits. The skeleton lay on its back, slightly inclined to the left, and in a contracted position, with the legs bent against the thighs and the thighs half flexed upon the body, the left arm extended by the side, the right flexed. The skull lay on its left side, and the lower jaw was considerably separated in front from the upper as if the mouth had been widely open. All the bones of the skeleton, even though damaged, were still in their proper anatomical positions; only the smaller bones of the feet and the right hand had been displaced, probably by small animals. The bones were removed with all possible precautions, in some cases with blocks of the deposits, and were taken to Professor Boule's laboratory in the Paris Museum of Natural History, where eventually they were cleaned and studied and where they are now preserved.

The consensus of opinion of those present was that the remains represented a regular intentional human burial. The three flat stones and the broken animal bones had probably been placed designedly over the skeleton. It was believed, however, that there had been no burial fossa, the body having been placed on the old (Acheulian) surface and covered with broken bones, débris, and perhaps skins and branches, to become in the course of time further buried by kitchen refuse and newer accumulations.

The explorations by M. Peyrony and his associates in the La Ferrassie rock-shelter continued, the work resulting within the next year in additional discoveries of human remains. These consisted of another skeleton of an adult, in poorer condition; and of several burials of infants, in which however the human bones have mostly disappeared.

The second skeleton was discovered in September, 1910. It lay in the middle of the same Mousterian layer, five feet from the rocky wall of the shelter, and with the head only 20 inches from that of the first skeleton. The skeleton lay at the same level and in the same axis as the first one, but in an inverse position, the heads approaching each other, the rest of the bodies extending in opposite directions. The body had also been flexed and lay on its right side, the hands resting on the knees.

The bones of the lower members were fairly well preserved, those of the upper limbs only partially; of the thorax there were but a few remnants.[1] The burials of the infants came to light in subsequent work.

In 1923 M. Peyrony very kindly accompanied the writer to the shelter, where a portion of all the layers has been left as an archeological monument. At that time it was still possible to discern three shallow, slightly darker depressions that originally contained the bodies of the infants. In M. Peyrony's opinion, all the subjects found in the shelter received intentional burial, though its exact nature was still a subject for speculation.

The remnants of the second adult skeleton are also preserved under Professor Boule's care in the Paris Museum of Natural History. The specimens have not yet been described separately, or exhaustively. They are reported upon partially by M. Boule, but the data concerning them are scattered in his Mémoir on the fossil man of La Chapelle and in his book on "L'Homme fossile."[2]

DESCRIPTIVE NOTES ON THE LA FERRASSIE REMAINS

THE CRANIA

All that can be done in describing the specimens is to utilize the partial notes of Professor Boule, adding to them such observations as were possible to the writer in his brief views of the otherwise still unavailable originals.

Skull No. 1, relatively well preserved, is plainly that of a male; skull No. 2, defective, is that of a female. The male was about middle aged, the female adult, age uncertain. The brain portion of the male skull is striking through its large size; it appears to be at least as large as the La Chapelle. It belonged to a male taller but somewhat less muscular than the latter specimen. The second skull was evidently of but moderate proportions and belonged to a short female.

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[1] Capitan and Peyrony, Station préhistorique de la Ferrassie. Rev. anthropologique, Vol. 22, pp. 29-50, 76-99, 1912.

[2] Boule, M., L'Homme fossile de La Chapelle-aux-Saints, Paris, 1913. Fossil Men, London, 1923.

In form the skull of La Ferrassie No. 1 resembles in many respects that of La Chapelle, but it also differs from the latter in some points, including a somewhat less primitive face. The vault is large and spacious, and in all important respects much like that of the La Chapelle cranium. The supraorbital arch, the forehead, the low vault, the occiput, the far-back location of the parietal fossae, are all close to those of the La Chapelle. The mastoids are of only moderate size. The basal parts of the temporal bone are badly damaged in No. 1, but in No. 2 show characteristics like those in the Spy and Krapina skulls.

The face presents, below the heavy arches, similarly inclined orbits as in La Chapelle, similar relatively small and sloping malars with broad frontal processes and stout zygomae, and similar fullness of the suborbital (canine) surface. The nose is broad. The facial prognathism is not excessive. The dental arch is large, the palate approaches **U**-shape. The teeth, all present, are stout; the crowns are worn, especially anteriorly where the pulp cavities are exposed.

The lower jaw, although large, is distinctly nearer to the modern type than are the other Neanderthal jaws with the exception of Spy No. 1. It shows clearly the beginning of a chin. The jaw is neither very high nor very thick, measuring 3.3 cm. in height at the vertical passing through the mental foramen, and 1.5 cm. in thickness at the same section. The mandibular angle is 109°. The ramus is broad; the region of the angle is still rather primitive, approaching, though not equalling, the form observed in the La Chapelle jaw; but the sigmoid notch is well developed, as in modern man. The condyle is stout and of the same dimensions as in La Chapelle. There is still a marked space between the last molars and the anterior border of the ramus on each side, as in other early jaws. The form of the lower dental arch of La Ferrassie No. 1 approaches that of the upper arch. When the jaws were closed the upper and lower incisors met exactly.

The intracranial cast of the male skull from La Ferrassie is reported by M. Boule to be "at least as large as that of the specimen of La Chapelle-aux-Saints."[1]

THE SKELETAL PARTS

There is no complete description of the bones of the La Ferrassie skeletons, but numerous notes and data on the parts are scattered through Professor Boule's Mémoir on the La Chapelle skeleton, with some additional notes in his book on "Fossil Men." The two skeletons show marked sexual differences, No. 1 being that of a fairly tall male (for a Neanderthaler), while No. 2 is that of a low-statured woman. Many parts of both skeletons are absent or more or less imperfect. The bones that remain resemble in essentials the bones of the La Chapelle, Neanderthal, and Spy skeletons; there are, however, various differences, some of the parts such as the scapulae being even a trace more primitive than the corresponding bones of other Neanderthalers, while others show more advance towards recent types. The main details follow:

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[1] Fossil Men, p. 473, 1923.

Humeri.—More slender in both skeletons than in Neanderthal, Spy, and La Chapelle; shafts less cylindrical. The male and especially the female humeri show above the middle a noticeable lateral bend. The male humeri are very perceptibly longer, the female markedly shorter than those of other Neanderthalers. The ends are robust; and all the bones show good sized olecranon perforations.

Radii.—Pronounced curvature of whole shaft, especially in the male; cup large, shallow; extremities relatively stout.

Ulnae.—Shape of shaft much more prismatic in both skeletons than in the Neanderthaler; flattening of upper part of shaft less marked, especially in the female, than in La Chapelle and Spy; olecranon stout.

Clavicles.—Male only. Relatively very long but not massive—over 54% of the length of the humerus (highest modern about 52%).

Scapulae.—A portion of the right scapula of the male shows on its dorsal surface a strong oblique ridge running from the base of the glenoid in the direction of the inferior angle; this is a primitive feature rarely approached in modern bones.

Ribs.—Male; less stout and more flat than those of La Chapelle, nearer to modern forms.

Hands.—Not yet reported in detail. Left hand of male nearly complete. Relative length of thumb in both skeletons nearer to modern than in La Chapelle. Fingers short, in both individuals.

Femora.—Bones robust, ends stout; anterior curvature of whole shaft, as in other Neanderthalers, somewhat less marked in the male, pronounced in the female; linea aspera better developed than in La Chapelle in the male, less so in the female; subtrochanteric flattening moderate, about as in the Spy femora.

The neck in the male bones is about as long as it is in modern femora; in the female it is very short (as in the La Combe Aurignacian skeleton). The digital fossa, preserved in the female, is large and deep. The lower part of the shaft is somewhat more cylindrical in both skeletons than in the femora of today; and the popliteal surface in bones of both individuals is slightly convex, as in the other Neanderthalers.

Tibiae.—Male bones, no heads; female, retroversion of head about as in La Chapelle, articular facets large, shallow. The bones are not platycnemic.

Fibulae.—Male; robust, relatively large extremities; shaft more flattened than in La Chapelle.

Astragalus.—" The astragalus or ankle-bone is short, high, and broad. The head is much bent, denoting that the great toe was widely separated from its neighbours. The articular surface for the scaphoid points to a much depressed instep. The malleolar facets for the tibia and fibula show a development comparable to that observed in apes. In its extent, the facet for the fibula recalls that of anthropoid types . . . . it is the astragalus of a walking mammal, which, however, has retained many relics of a former climbing state."[1]

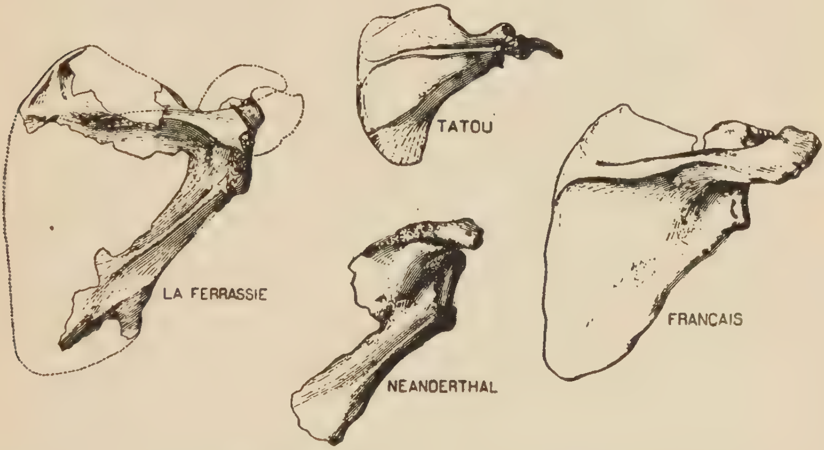

FIG. 26.—Scapulae of Neanderthal and La Ferrassie compared. (After Boule.)

Calcaneus.—Voluminous, stocky, long; sustentaculum much developed; articular surfaces more primitive than at present.

Bones of the feet.—Indicate a considerable separation of the first toe; the scaphoid is thick; the metatarsals are robust and with stout ends; the first metatarsal is relatively voluminous in the male, with shaft flattened and ovoid as in apes rather than man; in the female the bone is relatively short.

Pathological (Hrdlička).—Male: Lower part of one femur and a tibia show periostitis with slight osteitis—much as in syphilis.

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[1] Boule, M., Fossil Men, pp. 220-221, 1923.

CRITICAL REMARKS

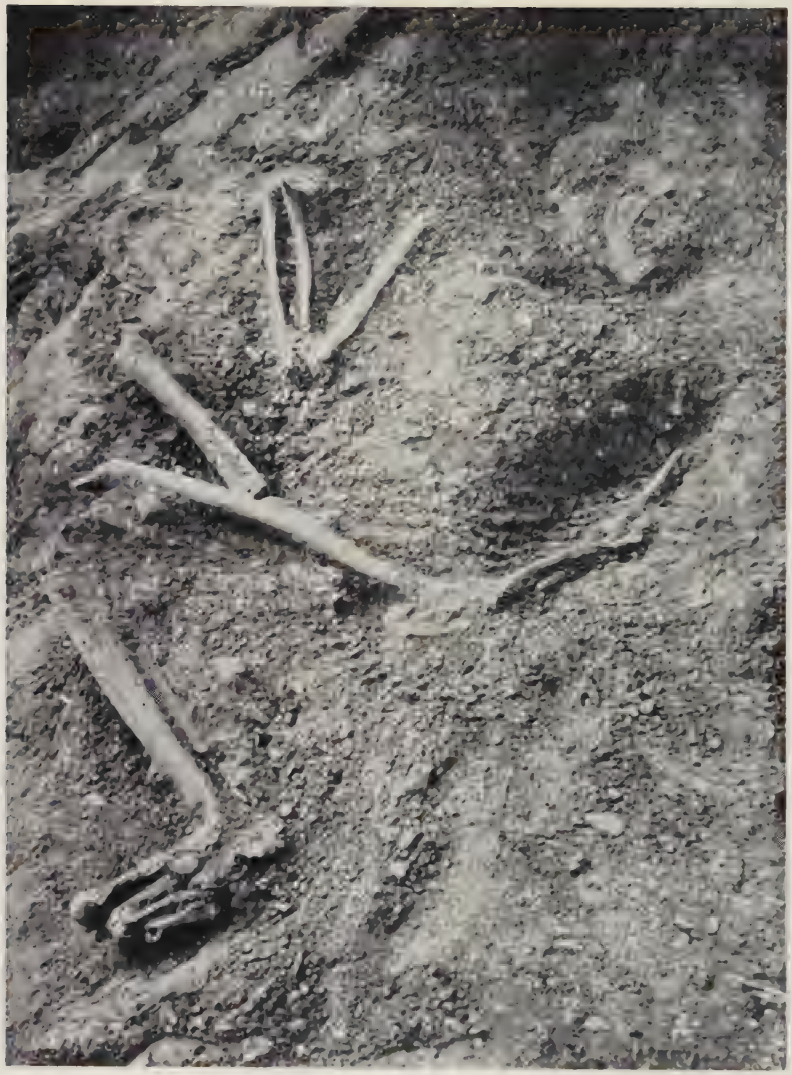
Eighteen years have elapsed since the discovery of the La Ferrassie skeletons, yet they remain in general but very imperfectly known, for what has been reported on them by M. Boule is scattered in his reports on the La Chapelle skeleton and on those of the Neanderthal man in general. There are no adequate photographs, and no casts of the remains. Professor Boule has kindly and repeatedly shown the originals to the writer and other scientific men; but this is insufficient for the student of early man and could readily result in erroneous impressions. The causes of the regrettable delays are not known. They cannot, it seems, be due to Professor Boule who knows thoroughly, as shown in his work on the La Chapelle skeleton, the great value to all serious students of early man of reliable photographs and casts, and of the ready availability of such originals for scientific study.

The two La Ferrassie skeletons are of especial importance, on one hand through their many characteristics which connect them clearly with the Neanderthalers, and on the other hand through a series of features in which they approach more modern man.

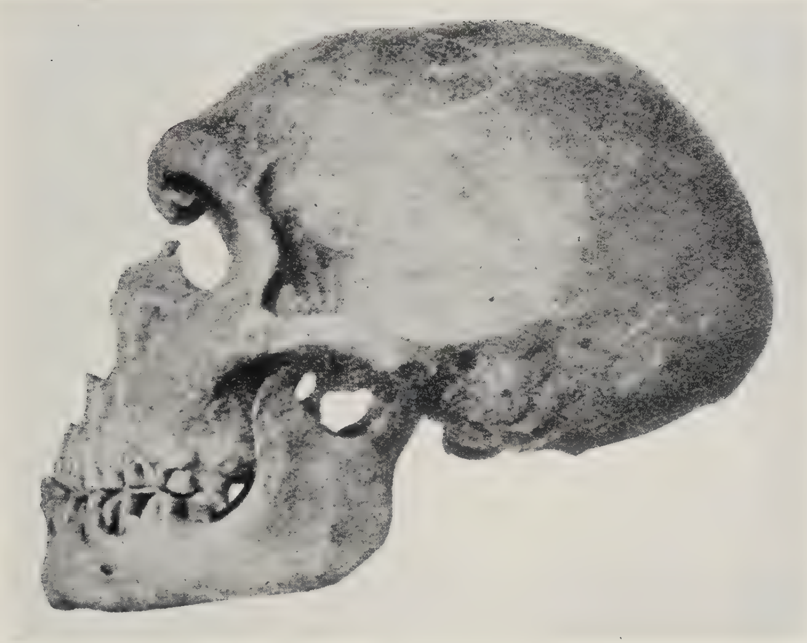
The burials themselves are of importance. M. Boule suggests ("Fossil Men," p. 190, 1923) that "It would appear there are present here the bone remains of a whole family, killed by accident, perhaps beneath a land-slip." This opinion is apparently not borne out by the details reported by Capitan and Peyrony. There were no signs of any such fall as could have killed the whole family; the infant burials were apart from those of the adults and near each other; the adults lay in a line, with heads near each other; the three flat stones over the male skeleton were evidently selected and lay in a definite order; both the bodies were flexed, as at La Chapelle—a feature that prevailed from the paleolithic to neolithic and even later burials; their positions otherwise indicate a laying down of a body rather than an accidental burial; and the skeletons were not covered with the débris of a fall, but with intentionally broken bones, implements, and human refuse.

Neither can the opinion of Capitan and Peyrony, that the bodies were placed superficially in the corner of the cave, covered with only skins and branches, and left thus until covered by new refuse of habitation, be reasonably sustained. The decomposition of the bodies in a shelter of this nature would have made the stay of their relatives impossible, and if they left, the bodies would have been devoured or torn to pieces by the hyenas or other animals.

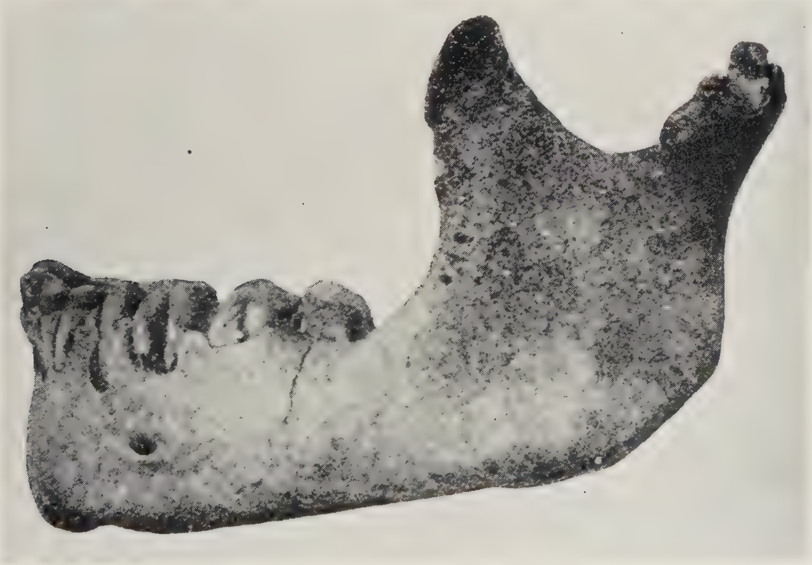
The La Ferrassie rock-shelter shortly after the discovery of the first skeleton, showing a distinguished company—Boule, Breuil, Capitan, Cartailhac, and Peyrony. (After Capitan and Peyrony.)



The first (♂) skeleton at La Ferrassie, before removal. (After Capitan and Peyrony.)



1. Skull of male skeleton from La Ferrassie, seen in profile. (After Boule.)



2. Lower jaw, seen in profile, of the man from La Ferrassie. Three-fourths natural size. Paleontological Gallery of the French National Museum of Natural History. (After Boule.)

All the evidence indicates that the inhumations at La Ferrassie were true intentional burials, in shallow but sufficient fossae, and covered at the time of the burial with the bones and other materials that were found above the skeletons.

Shallow burials in occupied caves or beneath the floor of a dwelling, of infants and even adults, in very much the same postures, are well known to the American archeologists, and these cannot but be forcibly impressed by the close resemblance of the conditions at La Ferrassie to what they have witnessed over and over again in old Indian caves and habitations.

The Mousterian layer containing the La Ferrassie skeletons was, however, but 50 cm. (19 ins.) deep. Could the inhabitants of the shelter have buried the bodies in such a thin deposit?

There are several possible explanations. The deposits, before becoming as packed down as they eventually did, were doubtless considerably thicker. Such packing is well known to prehistorians in other cases. A portion of the deposits may have been removed by wind, water, or sweepings. Or, the bodies were introduced later, perhaps during the lower Aurignacian occupation. The incised bone would seem to lend some support to this supposition. This thought, of course, meets opposition in the common belief that all the Neanderthalers disappeared before the Aurignacians. Yet next to nothing is known as to the physical type of the earliest Aurignacians. It is not impossible that, when better known, not a few of them may be found to resemble more or less closely their Mousterian or Neanderthal predecessors—perhaps ancestors. Such thoughts are of course quite heretical.

THE LA QUINA REMAINS

On October 16, 1911, Dr. Henri Martin, well-known physician and prehistorian of Paris, reported to the Académie des Sciences of Paris the find of a very remarkable ancient human skeleton at La Quina, Department of Charente, in France.[1] "We have discovered," he says, "on the 18th of September, at La Quina, a human skeleton of the Neanderthal type." It lay in a horizontal position, in clayey sand, at the distance of 4.5 m. from the base of a cliff. The deposits in which it rested represent the ancient muddy bed of the near-by stream Voultron, and belong, archeologically, to the lower Mousterian epoch. The clayey sand was covered by débris from the cliff portion, which in former times extended shelflike over the stream.

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[1] Martin, Henri, Sur un squelette humain de l'époque moustérienne trouvé en Charente. C. R. Acad. Sci. Paris, Vol. 153, p. 728, 1911.

The skeleton lay 80 cm. (2.6 ft.) deep in the sand, and was not surrounded by any objects which would indicate an intentional burial. Its location and position seemed to show that the body had been deposited where it lay accidentally. The clayey sand contained a few disseminated worked stones and a few bones that had been utilized by man, but showed none of the handsome pieces which characterized the upper Mousterian epoch. The skeleton is, in all probability, referable to the earliest part of the middle Quaternary.

The remains have suffered from prolonged submersion and pressure, as a result of which the cranial bones were disjointed and in part broken; but from the first instant it could readily be seen that the jaws, particularly the mandible, were heavy; and the teeth were large in size, besides showing other remarkable features.

The easily accessible prehistoric station of La Quina is known from the earlier days of prehistoric research in France. As early as 1873 excavations were carried on there by Gustave Chauvet; and in 1896 he published an account of them (Bull. Soc. archeol. et hist. Charente, p. 313, 1896).

Dr. Henri Martin began its exploration in 1905. In 1906 he announced before the Société prehistorique, the finding, among the upper Mousterian industry of the site, of phalanges of prehistoric horses, bovidae and large deer, and some lower ends of animal humeri that showed utilization by man (as anvils and perhaps hammers in the working of flints).[1] A little later in the same year and before the same society, Dr. Martin reports on some remarkably well made flint implements from the same depoits, and on the evident differentiation of the stone industry towards forms of more advanced varieties.[2] In 1907 Dr. Martin reports on new excavations at La Quina[3] and gives details as to the stratigraphy of the deposits.

The entire deposit exists in the wooded slope—in places a sloping terrace—lining the southwestern limestone cliffs of the small valley of the Voultron. The cliffs themselves, it was learned later, contain some caves. The mass of deposits at the site explored by Dr. Martin is shown in plates 74 and 75. It consisted of the following:

Surface vegetal earth overgrown with bushes and trees, 40 cm.

A thick layer of fallen rocks and débris—1.20 to 5 m. [The great amount of fallen rock, among which are very large blocks, indicates the former existence here of one or more rock-shelters, such as found about Les Eyzies—Hrdlička.]

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[1] Ossements utilisés par L'Homme moústérien de la station de La Quina. Bull. Soc. préhist. France, 1906.

[2] Industrie moustérienne perfectionnée station de La Quina. *Ibid.*

[3] Nouvelle coupe de la station moustérienne de La Quina. L'Homme préhistorique, Vol. 3, No. 11.

THE ARCHEOLOGICAL DEPOSITS

No. 1 on the chart shows the upper sandy portion of the Mousterian deposits;

No. 2 is a large argilaceous layer with high class Mousterian implements and utilized bones;

No. 3, argilaceous sand, with Mousterian industry;

No. 4, a thin layer of fine sand without either industrial or faunal remains;

No. 5, gravels, with first horizon of Mousterian industry;

Nos. 11-12, layers of waterworn limestone fragments, without industry.

In 1908 appeared Dr. Martin's first report on the fauna of La Quina, and in this communication[1] is found the first report of human skeletal remains, in the form of a pair of astragali. These astragali were reported upon by Dr. Martin with handsome illustrations, in 1910.[2] The bones were found to differ from modern ones in the shortness of the neck, internal deviation of the head and its marked rotation outward, in the expansion and large development of the sustentaculum, and in some other particulars. The bones are larger in all dimensions than those of modern Europeans; they measure in maximum length 5.1, in maximum breadth 4.7, and in maximum height 3.1 cm. A number of other measurements are also given.

At the same meeting Dr. Martin reported in detail on the animal bones from the La Quina deposits that show human work.[3] The utilized bones include anvils, hammers, compressors, polished pieces, awls, artificially perforated phalanges, and bones with some intentional gravings. At about this time appeared also Dr. Martin's larger study on the evolution of the Mousterian industry of La Quina.[4]

In 1911 came the first report on the find of the first human skeleton. In the Comptes rendus of the Academy of Science, Paris (T. 153, pp. 728-30), Dr. Martin gives a brief report of the discovery with a photograph of the skull *in situ*.

The skeleton, in Dr. Martin's opinion, was plainly " in place " and had suffered no disturbance, so that it was possible to refer it to the base of the middle Quaternary. The skull was believed to have suffered a prolonged maceration as a result of which the cranial bones were disjointed, but their preservation was such that the cranium will be easy of reconstruction. The skull, as far as it was possible to judge at the time of the report, appeared to offer all the primitive characters of the Neanderthalers, and perhaps even more. The remains were generously promised as a gift to the Paris Museum of Natural History, where they are at present.

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[1] La faune moustérienne de La Quina. C. R. Assoc. franc. Acad. Sci., pp. 727-730, 1908.

[2] Astragale humain du moustérien moyen de la Quina. Bull. Soc. préhist. France, 1910, pp. 391-397.

[3] Traces humaines laissées sur les os a l'époque moustérienne (La Quina). C. R. Assoc. fr. Acad. Sci., 1910, pp. 142-145.

[4] Recherches sur l'évolution du Mousterien dans la gisement de La Quina.

That same year (1911), Dr. Martin made a more detailed report on the skull to the Sociétié préhistorique, which is followed, in 1912, by a second and third, and in 1913 by a fourth report on the cranium,[1] with many details on the now reconstructed specimen, many measurements, some discussion of the opinions held by the discoverer, especially as to the burial of the skeleton, which he strongly holds to have been accidental, and finally an interesting effort at reconstruction of the head of the La Quina woman—for the skeleton is now regarded as that of a female.

Meanwhile, in 1911, Dr. Martin discusses again[2] the nature of the La Quina deposits and their archeological contents, some of which show forms that seem to some observers to be perhaps Aurignacian. Of the two interesting paragraphs in conclusion the first reads:

> But here, as in many other deposits of early man, there are evidences of transition and of precursor-implements which are of the highest interest, for they denote a transformation, a progress towards the better; at the same time certain persistences, such as those of the *coups-de-poing,* indicate simply the prolonged use of a good tool.[3]

Towards the end of 1912 Dr. Martin enumerates, in a brief report to the Academy of Sciences in Paris,[4] the human skeletal remains found in the La Quina deposits up to that date. They comprised:

Year	Layer	Parts
1908	C 3	2 astragali, evidently of same skeleton.
....	B 2	Fragment of an occipital.
1910	C 2	A dorsal vertebra.
1911	C 2	2 lower molars, of probably the same individual.
....	B 3	Skeleton.
1912	B 2	Piece of a parietal.
....	C 2	Fragment of right frontal, with portion of the supraorbital arch.
....	C 2	Fragment of left frontal (the two may not be from the same subject).
....	C 2	Lower jaw.

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[1] Bull. Soc. préhist. France, 1911 Rep., 12 pp., 3 pls.; 1912 Rep., 36 pp., 3 pls.; 1912 Rep., 8 pp., 1 pl.; 1913 Rep., 4 pp. Another brief note on the " Skull of the Mousterian fossil man of La Quina " is found in the C. R. Assoc. fr. Acad. Sci., pp. 537-538, 1912.

[2] Les couches du gisement de La Quina et leur age. Sixième Congrès préhistorique de France. 1911 Rep., 4 pp.

[3] " Mais içi, comme dans beaucoup d'autres gisements, il y a des termes de passage et des outils précurseurs, qui sont du plus haut intérêt, car ils dénotent

These remains appeared to Dr. Martin to have proceeded from nine skeletons. All the remains showed Neanderthal affinities. None, he believed, were from intentional burial; there were no traces of cannibalism.

A further report by Dr. Martin on the discovery of fossil man of La Quina, in 1912,[1] contains some interesting passages that deserve to be quoted in full. In these the author says (pp. 63-64):

> At the base of the [La Quina] deposit we have found flint implements with very simple flaking, while at their top the work reaches a greater perfection; this modification in the industry proves that the Mousterian period was very long and that a palpable cultural progress was realized during the period.
>
> Why not then admit that the author of this progress has also himself become perfected on the spot, and that his procedure as well as his work became more delicate? It is surely rational to admit that his dawning intelligence augmented his cerebral mass. The bestial aspect left his physiognomy, his traits became finer—all this meaning progress towards present conditions. . . . We feel authorized to say that according to the present state of our knowledge, this Neanderthal race, which eventually disappeared, still manifests itself occasionally by atavism, in exceptional development of the supraorbital arches; but this ancestral stigma is no more accompanied by other characteristics so peculiar to primitive man.

In 1913, Dr. Martin reports on the robustness of the La Quina and other Neanderthal lower jaws.[2] He has developed a promising new graphic technique for the presentation of his results. The Neanderthal mandibles show considerable uniformity in strength.

For the next few years Dr. Martin devoted himself as much as practicable to further explorations at La Quina, and to the preparation of his final memoirs. But the war intervened and he became a surgeon in the army. Nevertheless a supervision of the deposits was carried on by Mme. Martin and one of the young sons, a happy result of which was the discovery, on August 23, 1915, of a unique skull of a

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une transformation, un acheminement vers le mieux; de même certaines persistances, celles des *coups-de-poing* par exemple, indiquent simplement l'usage prolongé d'un bon outil.

"Plus tard, lorsque j'aborderai l'étude des nombreuses formes de silex recueillies depuis six ans, il me faudra décrire des pointes avec des crans, et j'espère que ce mot ne fera pas naitre chez les archeologues étrangers l'idée d'introduire à La Quina du Solutréen supérieur."

[4] Répartition des ossements humains trouvés dans le gisement moustérien de La Quina. C. R. Acad. Sci. Paris, Vol. 155, pp. 982-983, 1912.

[1] A propos de la découverte de l'homme fossile de la Quina. Rev. études anciennes, Bord., Vol. 14, pp. 61-64, 1 pl., 1912.

[2] A propos de la robusticité du maxillaire inférieur de l'homme Néanderthalien. Bull. Soc. préhist. France, 8 pp., 1913, reprint.

Neanderthal child. The report of the discovery in the form of a letter from Mme. Martin which reached the Doctor in a military hospital reads as follows: " As a result of a falling down of some of the deposits we have seen appear, in the course of the diggings, the skull of an infant. It was taken out with the block of surrounding earth and transported to the laboratory in Peyrat "—Peyrat being the summer chateau of the Martin family, a little over a mile from the excavations. The skull was found in the deposits of the upper Mousterian. There were no marks of a regular burial. Judging from its position the skull is somewhat less ancient than the skeleton found in 1911.

The first report on the new specimen appears in the Bulletins et Mémoires de la Société d'Anthropologie de Paris, in 1920 (pp. 113-125). Actually the skull was the eighteenth separate piece of human skeletal remains found in the Mousterian deposits of La Quina. The same report gives a good illustration of the skull as contrasted with the skull of a modern child. The interesting specimen has belonged evidently to a child about eight years of age. The skull is fairly large but relatively low, and approaching the Neanderthal skulls in type. The supraorbital arches are not yet strongly developed, though much more indicated than they are in a modern male child of that age.

After giving detailed descriptions and numerous measurements on the specimen, Dr. Martin concludes: " By its form and other characters the skull offers the infantile stage of the Neanderthal type. While still presenting numerous primitive features the skull is marked by its good cranial capacity. The specimen enables us to see that the specific characters of the Neanderthal man became accentuated quite early in life."

In August, 1921, at the meeting of the French Association for the Advancement of Science,[1] Dr. Martin reports still an additional find of interest, from the deposits of La Quina, consisting of a neanderthaloid patella, which he designates as No. 19 of the human skeletal remains in the deposits. This piece was found in the Mousterian layers in 1920. It differs from recent patellae by its stout summit, and by the conformation of its posterior surface which is concave and lacks the median ridge. The bone is also relatively high in relation to its breadth.

Principal measurements: Height, 4.8; breadth, 4.3 cm. The bone was a trace higher, but considerably narrower than the patellae of Spy No. 2.

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[1] Rouen Session: Étude d'une rotule humain trouvée dans le moustérien de La Quina, pp. 955-958.

Partly before and partly since the preceding publication, Dr. Martin has finished the three volumes of his detailed studies. Regrettably these volumes are not as well known outside of France as they deserve to be. They contain not merely all the separately published studies but also much additional work with many illustrations. The last volume is devoted especially to the human skeletal remains.

This volume was published in Paris in 1923.[1] Here in 260 pages, Dr. Martin enumerates the skeletal finds up to date, and then deals exhaustively with the La Quina skeleton.

The remains comprise now the following:

H 1, H 1′—1908, layer C 3: 2 astragali, right and left, found at a short distance from each other; of same proportions and belonging probably to the same individual.

H 2—1908, layer B 2: Fragment of an occipital, with the right half of the occipital torus.

H 3—1910, layer C 2: A dorsal vertebra, near the 9th.

H 4, H 4′—1911, layer C 2: Lower left M3 and lower right M2; found about 3 feet apart.

H 5—1911, layer B 3: The human skeleton; skull with lower jaw, cervical vertebra, humerus, femora.

H 6—1912, layer B 2: Fragments of a parietal.

H 7—1912, layer C 2: Fragment of the left frontal, with a part of the supraorbital arch.

H 9—1922, layer C 2: Lower jaw, with 5 molars; chin less sloping; teeth in very good condition.

H 10—1913, layer B 3: A left temporal; very robust; found 3 feet above skeleton H 5.

H 11—1913: Occipital, fragment of the left region; occipital torus developed.

H 12—1913: M2, fragment of left frontal, with supraorbital arch (broken) and orbital roof.

H 13—1913; M2, fragment of a parietal.

H 14—1908; H 1: Portion of a left parietal of a young subject.

H 15—1913, layer B 2: Posterior part of the right parietal of a young subject.

H 16—1913, layer C 2: Fragment of a left temporal.

H 17—1913, layer C 1: Left lower canine.

H 18—1915, layer C 2: Skull of a child, aged about 8 years; discovered by the wife and a son of Dr. Martin; the lower jaw missing.

H 19—1920, layer B 3: Left patella.

H 21′, 22′, 23′—1921, layer C 2: 4 teeth (left upper M2, left upper M3, right upper Pm, root of a canine); these four teeth were found together.

For the many details of Dr. Martin's erudite study of the skeleton, the student must consult the original. The main conclusions are as follows:

Sex: Uncertain; certain indications and a relative slenderness of the bones would indicate a female, but the heavy supraorbital arches, zygomata, jaws, and teeth are not female.

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[1] L'homme fossile de La Quina, 260 pp., numerous illustrations, Paris, 1923.

Age: The individual was a fairly young adult.
Type: One of the most characteristic of the Neanderthal variety.
Stature: Moderate, not perfectly vertical.
Brain: Small, poorly developed anteriorly.
Teeth and Jaws: Much stronger than modern.
Musculature: Powerful, especially that of the neck and the jaws.
Great Toe: Apparently opposable.

NOTES AND CRITICAL REMARKS

In 1912, thanks to Dr. Martin, the writer was able to see, in Dr. Martin's laboratory in Paris, the originals of the La Quina skeleton discovered a year before. In 1921 he saw the child's skull in Dr. Martin's laboratory at Peyrat. In 1923 he had the good fortune for eight days to be the guest of Dr. and Mme. Martin at Peyrat, and to participate in the exploration of extensive Aurignacian deposits on the slopes of La Quina not far to the right of the Mousterian site. Finally in 1927, thanks to M. Boule, he was able to glance once more over the originals, both the adult and the child, now preserved in the Musée d'Histoire Naturelle, Paris. Moreover, through the personal favor of Dr. Martin he has been enabled to obtain excellent casts of most of the remains as found, and of both of the reconstructed skulls. For all of this he wishes once more to express his most grateful acknowledgments.

Dr. Martin (pl. 74) is one of the most persevering as well as able workers in French prehistory. His summer chateau is near La Quina, and for over 20 years, except during the war, he has spent most of his spare time in the exploration of the deposits and in the cleaning, repair, and study of both the cultural and the skeletal remains that were recovered. Of the cultural and faunal remains there were vast quantities, reaching into the hundreds of thousands; yet every flint and every fragment passed through Dr. Martin's hands and was examined, the only assistance obtained, outside of labor, being that of members of his own family; and all this work at his own expense. May Prehistory have more Henri Martins!

The deposits in the slope and terrace at La Quina, taking that name in a broader sense, are still far from being exhausted, though as the work extends beyond the confines of the large original Mousterian site, the returns become much scarcer. It is not, however, impossible that new industrial foci may be found in these slopes which extend for a considerable distance along the face of the calcareous cliffs to the southwest of the Voultron. In 1922 considerable excavation was carried on in the upper parts of the slope to the left of the Mousterian site by the American School of Prehistoric Research. These excavations uncovered and emptied a moderate sized cave in the rocks—one of several in the cliffs—and moved a great deal of the earth in front of it, but without material results. Since 1923 the excavations have slowed down, other sites claiming Dr. Martin's attention.

The excavations of La Quina have been visited by probably more prehistorians than any other site of primitive man with the exception of those in the Vezère valley. The " station " is easily accessible and relatively easily worked, though all the work must be done in the open and is made difficult by the great quantities of fallen rock and débris from what were probably in olden times more or less overhanging rock-shelters.

The amount of archeological material and bones of animals recovered from La Quina is such that it has supplied many European and even some of our American museums. The archeological material is clearly Mousterian, and in general shows much differentiation as well as improvement from below upwards, but a distinction of definite strata, except in the case of the very lowest one, seems difficult. There was evidently a very long continued occupation attended with local developments.

Of the more especially interesting cultural traces, Dr. Martin mentions the find of a perforated canine tooth of a fox and also a perforated phalanx of a reindeer, both of which evidently served for pendants; pieces of black oxide of manganese, showing deep rubbing and indicating the use of the black pigment for some purpose; and on a series of the incisor teeth of horses, possible traces of a bit, which would imply the beginnings of domestication.

The fauna of the Mousterian layers of La Quina, as determined by Dr. Martin, consists essentially of the following forms:

Mammoth (scarce)
Horse
Bos primigenius
Bison
Reindeer
Deer (large)
Marmot
Cave Bear
Wolf
Hyena
A large feline (lion?)
Blue fox
Small rodents
Birds (including a vulture)

It is throughout a cold fauna; there are no traces, even in and beneath the lowest cultural layer, of animals of a warm period.

As to the skeletal remains found in the Mousterian deposits at La Quina, it seems that more than one interpretation is possible. For Dr.

Martin, as is well known, they represent simply so much refuse, except in the case of the skeleton, which he believes was buried accidentally in the mud of the river.

These views offer some difficulties. The writer, both as a medical man and as an anthropologist, has seen accidental as well as intentional burials of many sorts. In accidental drownings the body, as soon as decomposition sets in and the abdominal cavity is extended by gases, rises to the surface. It might, of course, be deposited in the bushes or the mud at the edge of a river, but in the case of a relatively small and sluggish stream such as the Voultron it is difficult to conceive how a body thus deposited or caught could be so completely and rapidly covered with silt as to be sufficiently buried and remain so. It would seem much more likely that the body was buried intentionally in the dry river silts by its congeners. In such a formation and after such a long time as has elapsed since the burial it could not be expected that any marked traces would remain of the fossa.

As to the other human skeletal remains disseminated through the higher deposits, the conditions would seem to agree with what may be noticed in many much more recent intentional burials. Decay, burrowing of animals, and movements in the earth itself are not seldom found to have played havoc with skeletal remains. There are Indian burials, for example, in which practically nothing remains of the skeletal parts. In others the bones of the same skeleton are found widely scattered. The skull may be *in situ,* with the lower jaw at a distance; the bones from the knees downward may be fairly well preserved and still almost in their natural position, with all or most of the rest of the body missing, barring perhaps a few teeth; and individual bones, especially those of the smaller kind, may be found at an unexplainable distance from its skeleton. The same agencies were active both in historic and in prehistoric times, and the far greater time elapsed must have been all the more potent in producing all sorts of irregularities. The conditions at La Quina would be easier of explanation if, as at Krapina, there had been detected evidences of cannibalism; but none of the human remains shows signs of intentional breaking, of fire, or of scraping and disarticulation.

That the remains were simply thrown out is inconceivable; and it is still more inconceivable that in some instances the parts thrown out would have been merely the astragali or the patellae or a few pieces of the frontal bones, etc. And these parts were not likely the remnants left by wolves or hyenas, for after the feasts of such animals, as I had ample occasion to see in Mongolia where all bodies are thrown to the wild animals, there remain besides the skull only the hardest parts of the long bones of the adults, while adolescents and especially children disappear entirely. Also if the bodies had been thrown out they would not have been torn to pieces on the spot, within a few yards of the habitations, but would have been dragged to a safe distance. Besides which, it is inconceivable that human beings with such brains as already possessed by the Neanderthalers would simply throw out the bodies of their dead in front of their habitations and leave them there with all the consequences.

Taking everything into consideration it seems more likely that the human skeletal remains at La Quina are those of regular inhumations. The idea that an intentional burial must leave forever a discernible trace of the disturbance is not sustainable. It is found time and again with Indian burials that no such disturbance can be perceived. It is well to recall that the bodies are covered with the same substances that have been excavated from the fossa into which they were laid; and that through rains and other causes there takes place in the course of time a packing which quite equals that of the original deposits, and which, unless there was a penetration of a very definite layer of sharp sand or gravel, leaves eventually no indications. How true all this is may be appreciated from a reflection of what happens with the body itself. The decay of the soft parts diminishes greatly its volume. It also means the presence of a great quantity of organic materials. Yet all this invariably disappears in old graves and the bones become thoroughly enveloped in whatever materials were originally above and about them. There are, moreover, very strong indications of intentional burials in most if not all the other cases of Neanderthal skeletons.

OBSERVATIONS ON THE SKULLS AND JAWS

(Hrdlička)

Very detailed and excellent descriptions of the La Quina skulls and jaws are given in his publications by Dr. Henri Martin. If the writer prefers to give in this place his individual observations it is for the sake of greater uniformity with the remaining reports in this treatise, all of which are in large measure from his original observations.

THE ADULT SKULL

The vault.—The skull places itself clearly, by all its characteristics, within the range of the Neanderthal type. At the same time the specimen has not a little of individuality; some of its features are very primitive and in some respects the specimen is quite puzzling.

The skullcap approaches near to that of Spy No. 1; the supraorbital arch, the broad depression above, the very low and sloping forehead, and the characteristics of the occiput are much the same as in Spy No. 1; but the La Quina specimen is narrow throughout, and its parietals do not rise into a fairly marked vertex as they do in Spy No. 1.

Sex.—The La Quina skeleton indicates a female rather than a male. The skullcap alone, except for the supraorbital arches, the zygomae, and to a slight extent the mastoids, would also be diagnosed as a female; but the arches, the mastoids (for a Neanderthaler) and above all the dental arches, the jaws and the teeth are much more masculine than feminine. Had these parts been found alone they unquestionably would have been diagnosed as having belonged to a male. If this was a female, therefore, she was very exceptional—as in Spy No. 1. It would seem more likely that both Spy No. 1 and the La Quina represent subaverage males. Cases of similar nature are known among primitive skulls and skeletons of our times. Of the pelvis, which would probably have decided the question, nothing unfortunately remains.

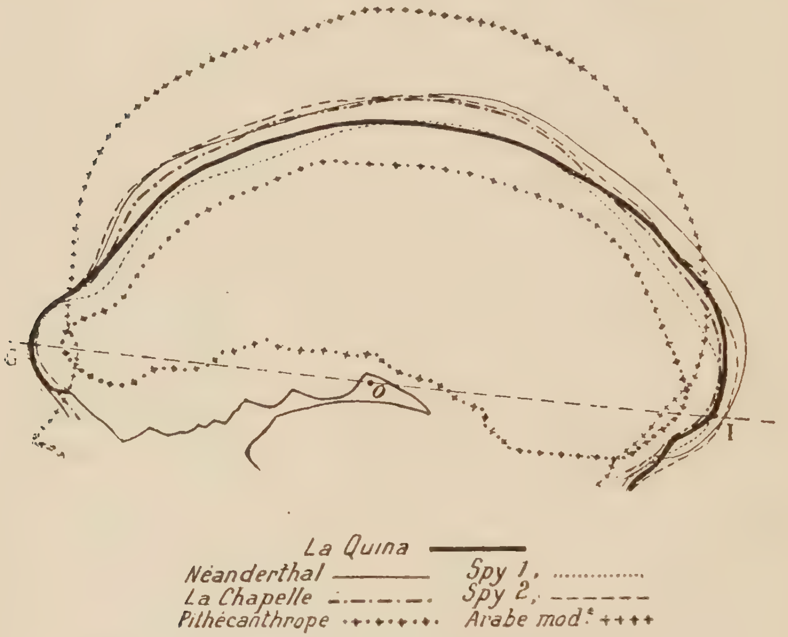

FIG. 27—Sagittal contours of the La Quina skull compared with those of other Neanderthalers, etc. (After Henri Martin.)

Age.—The patent sutures indicate a young adult. The wear of the teeth, if these were for instance Eskimo jaws and the teeth were worn off as they are in this individual, would indicate a fully adult stage, though not past the 35 year mark. With a broad leeway the La Quina individual may safely be placed at between 25 and 35 years of age.

Details: supraorbital arches.—There is complete meeting over the glabella, which itself is slightly elevated; the arches, which measure 15-16 mm. in thickness about the middle, diminish but slightly towards their distal portions. The maximum transverse diameter of the arches reaches only 11.4 cm., which is less than in any of the other Neanderthal adults.

The forehead is low, sloping, and narrow (see Dr. Martin's measurements). The nasion-bregma diameter or arc is longer than in Spy No. 1, but on the other hand the sagittal (B-Z) diameter or arc is shorter, the sum of the two being very nearly equal in the two specimens. These dimensions, as the student may readily satisfy himself on modern material, are largely of a compensating nature, and no great weight can therefore be attached to either an exceptionally short or an exceptionally long frontal alone.

The sutures are relatively simple. The parietal region, ovoid from side to side, shows but a slight ridging along the anterior two-fifths of the sagittal. It is remarkably low. The parietal bosses, as in other Neanderthalers, are situated low (only slightly above the mastoid parts of the temporal), though they are relatively a trace less posterior than the Spy No. 1 and the Neanderthal. The occiput, except for being narrower, is typical neanderthaloid, being moderately prominent with a flattening above and below. There is a rather marked occipital torus reaching on each side the lambdoid suture. The region below the torus is concave in its upper part, indicating the attachment of powerful nuchal muscles.

The temporal squamae are relatively small; the root of the zygomae forms a pronounced dull crest; the zygomae are stout; the meatus of moderate size; the mastoids above average feminine or submedium masculine. The temporal fossae were spacious; but the temporal lines are rather low and but slightly distinct.

The face.—The orbits are relatively large, high, and irregularly rounded as in the other Neanderthalers. The upper borders are less, the lateral and lower better defined. The nasal process of the frontal was evidently stout. The plane of the orbits, as in other Neanderthalers, was inclined downwards and forwards, and also somewhat more outwards and backwards than in modern skulls. The malars again, as in the other Neanderthalers, are relatively small, not prominent, and sloping outwards and backwards, but with somewhat broad frontal processes and zygomata. Nothing definite can be said about the nose but that it was evidently broad, and that there had existed more or less of a nasal spine.

The upper jaw is relatively very large. The shape of the palate was that of a broad **U**. The palate was rather deep. The alveolar process was very stout and fairly high, but not very slanting; there had existed evidently a facial rather than alveolar prognathism. The teeth are strikingly megadont.

The facial, as well as the cranial bones are not more massive than they are in many of the stronger built skulls of today, which is different from all the other Neanderthal crania.

The base.—The anterior parts are missing. The glenoid cavities are very shallow, but broad (transversely), extending from the overdeveloped spinous processes and the tympanic plate mesially, well onto the base of the zygomae laterally. There is no trace of a spine or a styloid; and between the tympanic plate and the mastoid there is a large space, even more marked than in the other Neanderthalers. There is also a broad space between the mastoid and the lateral edge of the basal portion of the occipital (digastric groove). Both of these features, due in the main to the lesser development of the mastoid, are characteristic of the Neanderthalers, and are absent (pre-mastoid space) or less marked (digastric groove) in human skulls of today.

The lower jaw.—The lower jaw is very primitive. It is stout, wholly chinless, and with the inferior portion of the posterior borders of the rami more curved and more anthropoid than in any of the other early mandibles. The alveolar border is stout, the teeth large. There is no diminution in the size of the molars backward.

The symphyseal region is broad and stout; the dental arch was **U**-shaped. The body, while not essentially high, in harmony with other Neanderthal mandibulae, appears nevertheless too high for a female. It is distinctly higher on the left than on the right side. Inferiorly the jaw presents much more of a definite dull border than do other Neanderthalers or the Mauer jaw. These is no trace of any shelf; and the anterior region, though very broad, approaches that in the jaws of today. The rami, above the modern average in breadth, are also rather high (H., approx., 7.8; Diam. min., 4.7 cm.). The condyles are broad, but not stout. The coronoid processes are about as in strong modern jaws, and the sigmoid notches are well marked—not shallow as in the other Neanderthalers.

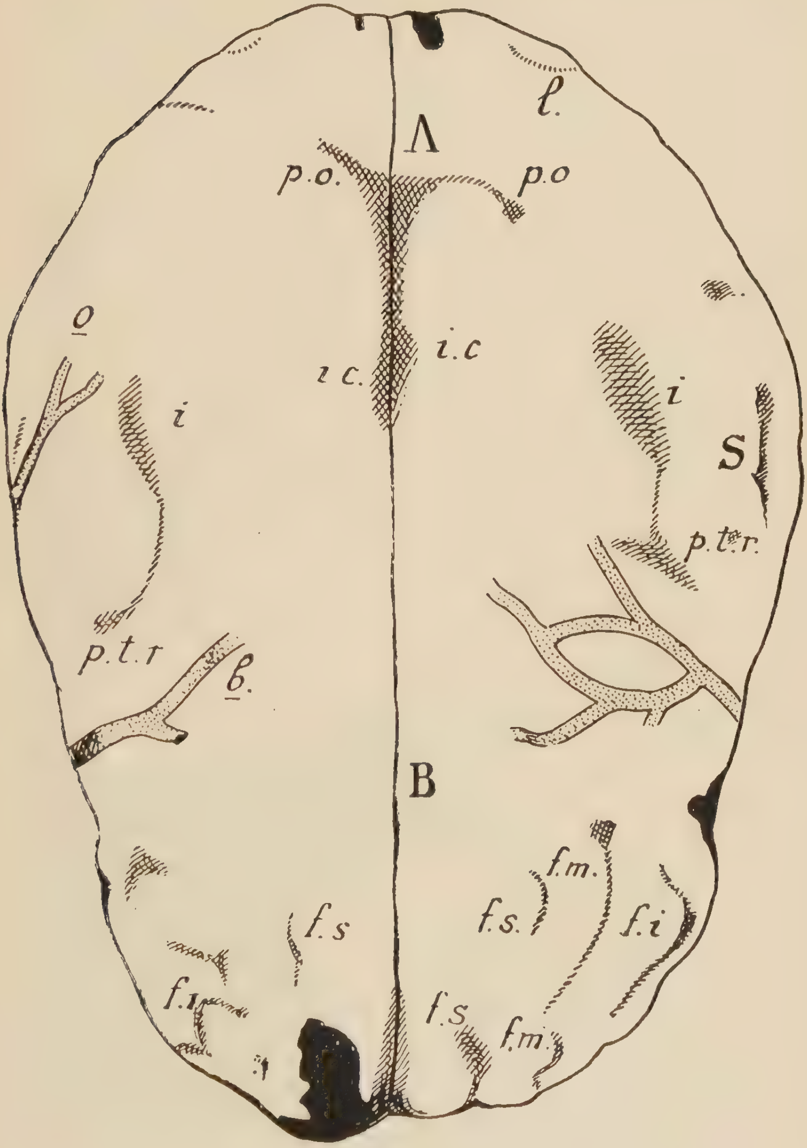
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FIG. 28.—Endocranial cast of the La Quina skull. (After Henri Martin.)

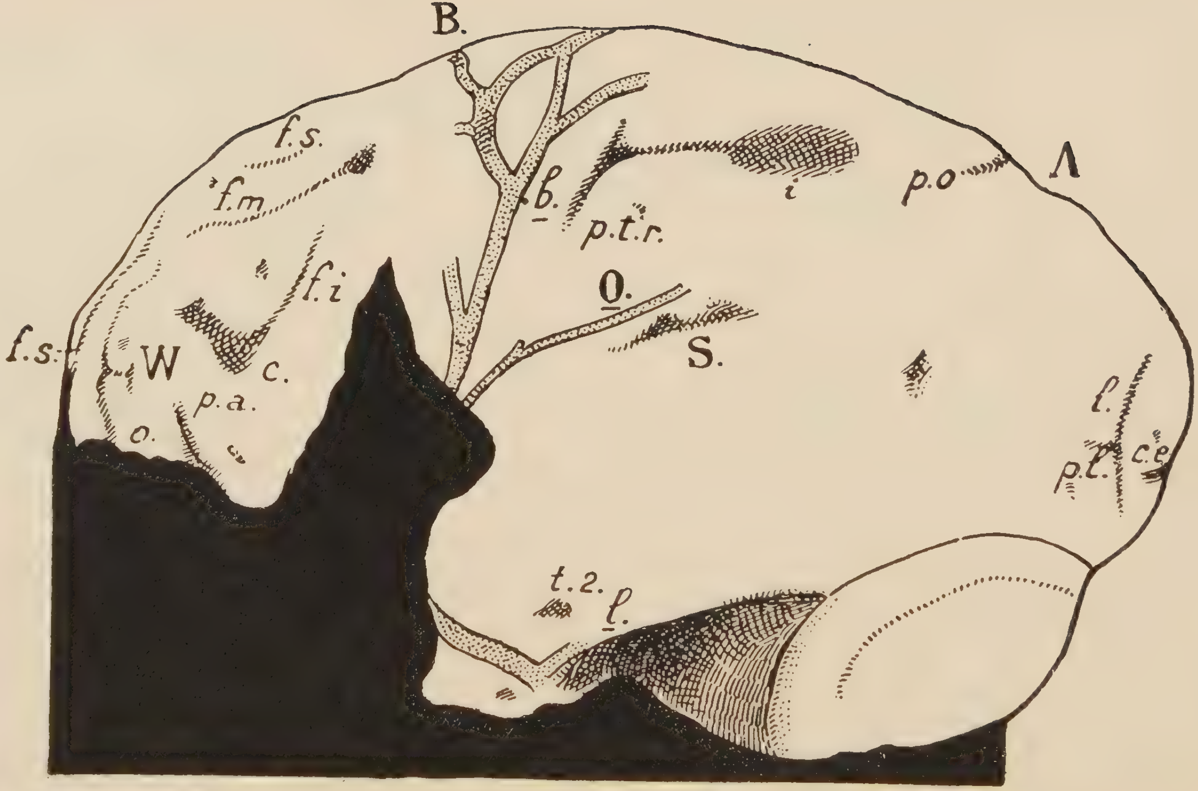
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Fig. 29.—Endocranial cast of the La Quina skull, side view. (After Henri Martin.)

Dorsally there is present on each side but especially on the right, a fairly marked dull ridge such as is seen in the La Chapelle jaw; but the condition is less developed and the ridges do not reach perceptibly the outer ends of the condyles. Anteriorly to them, however, there are marked fossae. Ventrally the rami are much like those in stronger modern jaws, but the mylohyoid ridge is more developed and the fossae for the internal pterygoids are very spacious.

The brain.—The brain of the La Quina skull was larger than that of Gibraltar, but smaller than those of the La Chapelle and Neanderthal crania. In form it was much the same as that of the other Neanderthal subjects, particularly those with the narrower skulls. There is a very marked smallness of the frontal lobes, a considerable overhanging of the occipital lobes of the cerebrum, and a marked separation of the two halves of the cerebellum. The left hemisphere shows a somewhat better development than the right, though the right appears to have been slightly longer. The convolutions of the La Quina brain were less simple and gross than those of the man of La Chapelle and Neanderthal, without reaching the average of the European brain of today.

In detail the brain presented some characteristics of inferiority, while in others it approached that of recent man. As in the La Chapelle and the Neanderthal brains, so also in that of La Quina the *sulcus lunatus* was certainly present. The relative development of the cerebral lobes was almost identical in the La Quina and the La Chapelle brains.[1] The cerebral breadth-length index of La Quina was *73.8*.

The teeth.—(After Henri Martin.) The teeth are more powerful than those of Spy and even those of Mauer. The crowns are large and bulging, the enamel thick (reaching 1.5 mm.). The roots are long and stout, their number tends in instances to an increase, and there is a marked inclination to doubling. M3 are as large as, if not larger than, M2. The pulp chambers are spacious. There is no trace of caries or of abscesses, but there is some tartar. The crowns show marked, somewhat unequal wear.[2] There is also on some of the teeth a marked contact wear, due to the crowding of the teeth against each other, the result of the large development of the crown.

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[1] The data on the La Quina brain are those of R. Anthony; they form a part of Henri Martin's 1923 memoir on L'homme fossile de La Quina, pp. 108-114.

[2] Would be called moderate according to American standards; no pulp cavity and but little dentine is exposed.

MEASUREMENTS OF THE LA QUINA SKELETAL REMAINS

(By Henri Martin)

SKELETON H 5—THE SKULL

	cm.
Length max.	20.3
Breadth max.	13.8
Cranial index	*68.0*
(La Quina child, H 18	*77.0*)
Length from ophryon ad max	18.3
Cranial index with ophryon length	*75.4*
Basion-bregma height, near	12.2
Mean height index (Hrdlička)	*71.6*
Height-breadth index	*88.4*
Height from glabella-inion line to vertex	7.95
Calottal index (Schwalbe)	*39.09*
Circumference (horiz.)	51.5
Arch middle of meatus over bregma	30.5
Diam. frontal min. (Broca)	10.0
Diam. frontal max	11.6
Nasion-bregma diam.	12.0
Bregma-lambda diam.	11.2
Lambda-inion diam.	6.2
Ext. biorbital breadth	10.2
Orbits:	
Height	3.65
Breadth	?
Nose:	?
Upper alveolar arch, ext. breadth max	7.75
Cranial capacity (obtained directly from displacement by intracranial cast)	1,350 c. c.

THE LOWER JAW OF SKELETON H 5, LA QUINA[1]

	cm.
Mean height of body	3.4
Mean thickness of body	1.5
Index	*44.15*
Symphyseal angle, about	109°
Ramus:	
Height	near 7.5
Breadth min.	4.7
External breadth between points on external alveolar border outside of M3	8.5
Mandibular angle, approx	110°
Condyle (right):	
Transverse diam.	2.5
Antero-post. diam.	0.9
Breadth of space between M3 and the vertical plane of the anterior borders of the rami	1.2
Breadth of space between M3, to the lower ends of the anterior borders of the rami	0.5

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[1] In part the measurements have been taken differently from those of other workers, and are not directly comparable except with those taken in the same manner.

PRINCIPAL MEASUREMENTS OF THE MOLAR TEETH[1] OF THE LA QUINA H 5 LOWER JAW

(After Henri Martin)

	M 1		M 2		M 3	
	r.	l.	r.	l.	r.	l.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Total length, crown	6.5	6.5	5.0	6.0	5.5	5.3
Root	14.5	15.0	15.5	18.0	16.5	17.0
Crown: Length (anterior-post. diam.)	12.0	12.0	12.5	12.3	11.5	11.5
Breadth (transverse diam.)	11.5	11.5	12.0	12.0	13.0	13.0

[1] In his 1923 volume, p. 144 *et seq.*, Dr. Martin gives exhaustive measurements of each of the 25 teeth that are present.

THE SECOND MANDIBLE (1912)

(Mainly after Henri Martin)

The second lower jaw (H 9) of La Quina[1] is represented by its left half only, but this is in a good state of preservation. The jaw is not as receding as H 5 and has a distinct reminder of a chin. The mental foramen is multiple, consisting of three larger and two smaller orifices, extending from I2 to M1. At the cross section between Pm2 and M1 the height of the body is 3.7, thickness 1.6 cm. [The lower jaw H 5 of the skeleton measures 3.4 by 1.5 cm., but the damage to the alveolar border makes the measurement somewhat uncertain, and on the right the thickness of the body was also about 1.6 cm. The body is distinctly higher on the left than on the right side (r. approx. 3.2; l. 3.5 cm.)] The axis of the condyles is less oblique than in modern man (same case in H 5). The mylohyoid ridge is stout, the fossa for internal pterygoid marked, much as in H 5. The ramus was high, not excessively broad; there is much more of an angle than in H 5, and the mandibular angle is more open; the sigmoid notch was fairly deep. The teeth are megadont, again as in H 5. At the angles the fairly sharp borders of the jaws are slightly inverted. The unevenness of the right and left sides of the jaw is remarkable. The right body is distinctly lower but stouter than the left, and the right ramus is distinctly lower as well as narrower, but at the same time stronger than the left. There is, therefore, the interesting and rather anomalous combination of a greater strength of both the body and the ramus on the right side, with a lesser development in height of both body and the ramus, and also a lesser breadth of the ramus.

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[1] Reported, briefly described, and pictured by Martin in: Position stratigraphique des ossements humains recueillis dans le Moustérien de La Quina. Bull. Soc. préhist. France, pp. 3-4, 1912, reprint.

THE SKULL OF THE CHILD

This skull is of somewhat higher grade than that of the adult. The vault is higher, and while still showing traces of the Neanderthal type, especially in the lower frontal and in the occipital region, it nevertheless could be much more nearly duplicated today. But there are features of the skull which attach it distinctly to the Neanderthalers. Although the specimen is that of a child not over eight years of age, the supraorbital arch is already plainly indicated and complete, and there is a shallow broad depression above it. The forehead, however, is quite as high and well arched as in mesocephalic skulls of children of similar age of today. It shows also not the single "cocoanut" bulge as in the negro, but a broad expanse which is like that in the crania of present white children.

The sutures are distinctly more simple than in a modern child. The parietals are formed much like those in modern mesocephalic skulls of children; but there is already perceptible the location of the parietal bosses which, as in the adult skull of La Quina, are almost directly above the mastoid region of the temporal. There is a distinct vertex; the lambdoid region is not more flattened than in children's skulls of similar shape today; neither is the occipital more protruding or more "undercut," or more flattened beneath the protuberance—in fact there is no flattening. The outline of the norma superior is an oblong ovoid, not yet as "baggy" behind as in the adult Neanderthalers. The temporal squamae are low—distinctly lower than in modern skulls of children, and the mastoids are much less developed, with the digastric groove broader and reaching higher on the left side, where a considerable part of it is quite external. The meatus is of about the same size as it is today but its vertical axis is not quite the same as in modern children's skulls.

The face.—The orbits are not of excessive size; their borders are still fairly sharp; their shape, as far as it can be told, except where affected by the rather peculiar border of the malars, shows little that is striking. The interorbital septum is not very stout. The nose is fairly protruding, concave, rather long, the nasal aperture broad. The suborbital (canine) fossae are full. There is but moderate facial or alveolar prognathism. The bones of the nose and maxilla appear to be somewhat stronger than they are in the modern child. The upper alveolar process (nasal floor to alveolar point) is rather low. The shape and size of the palate and the size and conformation of the milk teeth offer nothing very special; but the four incisors in eruption are all markedly shovel-shaped (scooped out on their lingual surface).

The base.—The glenoid cavities are remarkedly small and shallow. The pre-mastoid space is not yet well marked as it is in the adult La Quina. The condyles are small. There were evidently also other peculiarities, but the parts are too much damaged for correct determinations.

Principal measurements on the original (Hrdlička):

		cm.		cm.
Vault:	Length max.	17.2	Cranial index	*76.7*
	Breadth max.	13.2	Mean height index approx.	*78.9*
	Height, basion-bregma (but basion sm. unduly elevated, it seems, in reconstruction);	12.2	Height-breadth index approx.	*90.9*
	corrected, abt. (or possibly still a little less).	12.0		

NOTES ON PARTS OF THE SKELETON OTHER THAN THE SKULL

(Mainly after Henri Martin)

Atlas.—Of moderate proportions and strength; some peculiarities in details, especially as to anterior tubercle which is directed downward, as in other Neanderthalers (as far as known); odontoid facet very spacious.

Axis.—Much damaged; of moderate size and strength.

Other cervical vertebrae.—Defective; moderate size and strength; bodies not high; spinous processes wanting.

Bones of the limbs.—Badly preserved for the most part, and largely missing. What remains shows evident Neanderthal features.

Humeri.—Rather defective. The two bones are so different that they could be taken for bones of different skeletons; but they were found in place with the skeleton. The differences may probably be explained by some pathological condition affecting the left arm.

The right bone is much the stronger (circumference—r. 7.3; l. 6.2 cm.). [In size and strength and muscular impressions it is about equal to medium modern masculine.] The shaft of the right bone is somewhat flattened; transverse diameter, 2.6; antero-posterior diameter, 1.3 cm. [At middle the shaft is intermediary in shape between prismatic and plano-convex.] The lower third of the shaft approaches cylindrical. Near the nutrient foramen is an exostosis 11 mm. high, probably of traumatic origin.

The left humerus [upper ⅔] is much more slender, except in its lower extremity, which equals that of the right bone. The shaft in its upper third is near lozenge-shaped (on a cross section) [in the middle region prismatic]. Maximum transverse diameter, 2.1; antero-posterior diameter, 1.5 cm. Notwithstanding the slenderness of the bone, the muscular insertions are well marked [though not corresponding closely with those on the right bone].

The thickness of the walls is about the same in the two humeri; but the medullary canal of the left is much smaller (r. 13, l. 8 mm. in largest diameter). The transverse diameter of the lower end on the right is 6.3 cm., and on the whole, near in its characteristics to that of recent humeri. The olecranon fossa, however, as in other Neanderthalers is deep and spacious (2.9 broad, 2.2 high, and at least 1.3 cm. deep). The septum in the right humerus was not perforated, in the left shows a small aperture. The lower portion of the left humerus resembles that of the right.

Ulnae.—Present, right to olecranon only. The articular facets are relatively flat. The posterior surface indicates a strong triceps.

Femora.—The shaft of the left femur is nearly entire but epiphyses are wanting; of the right femur only about one-half of the bone (upper part) remains.

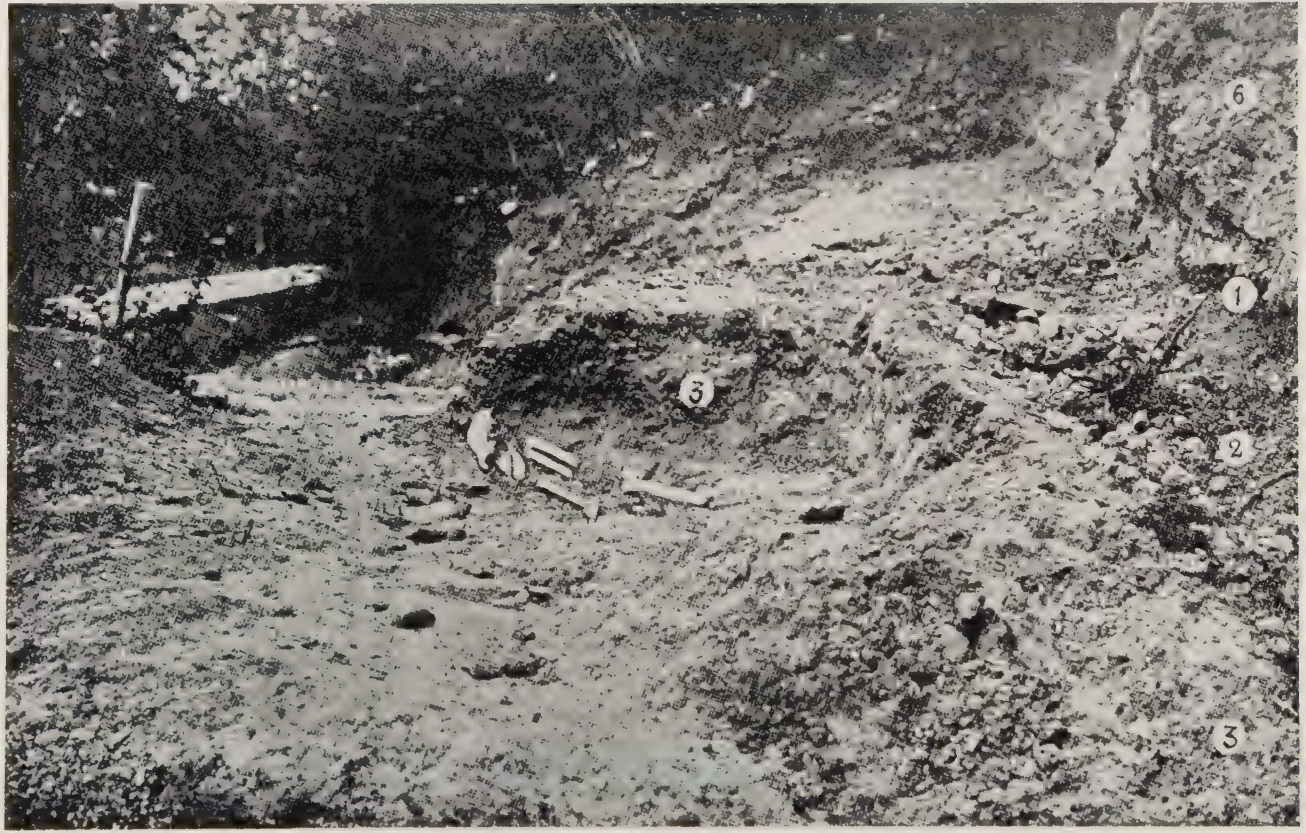
[In strength, size and other characters the bones approach closely a good modern medium male.]

MEASUREMENTS OF THE LEFT SHAFT (MARTIN)

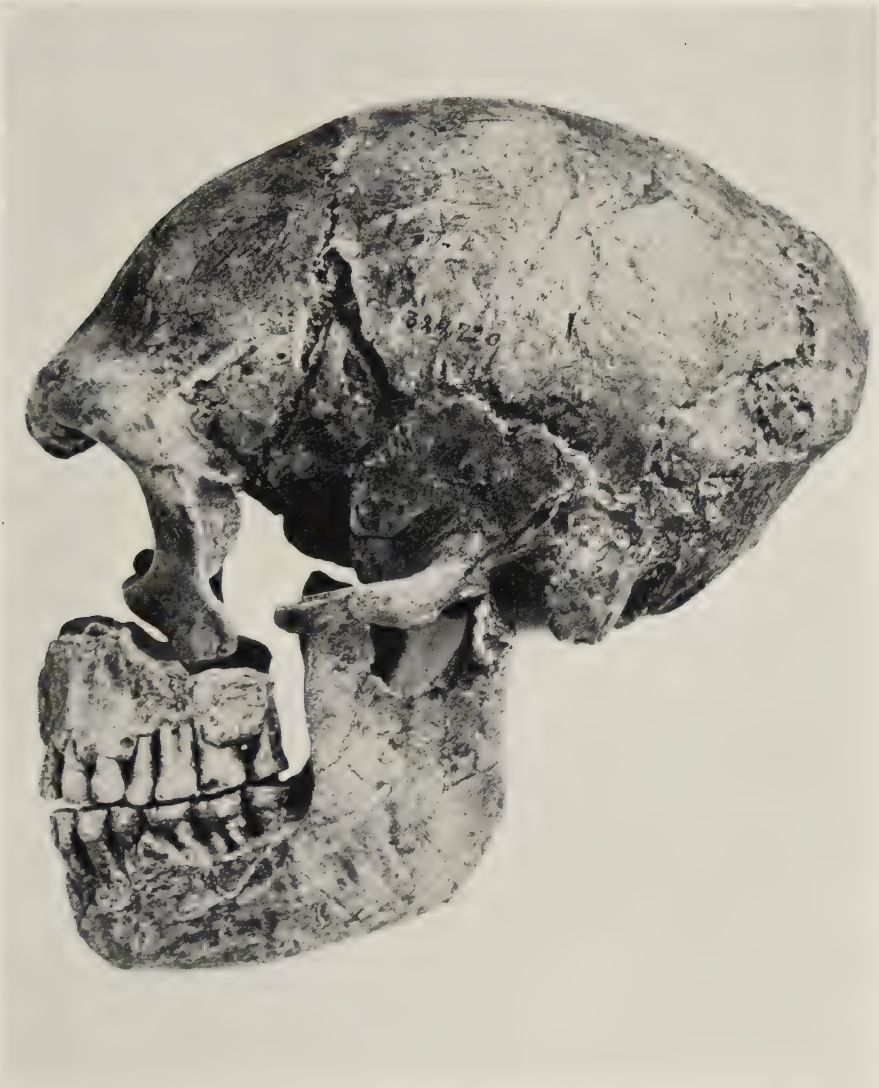
	cm.
At middle:	
Diam. antero-post.	2.6
Diam. transverse	3.0
Circumference	9.0
At upper flattening:	
Diam. min.	2.6
Diam. max.	3.35
Index	*77.6*

The later index shows that there was but moderate flattening. About its middle the shaft approaches cylindrical, with the linea aspera but slightly developed. The popliteal region is wanting. The whole shaft is moderately arched forward, resembling thus the other Neanderthal femora. There is no hypotrochanteric fossa. What

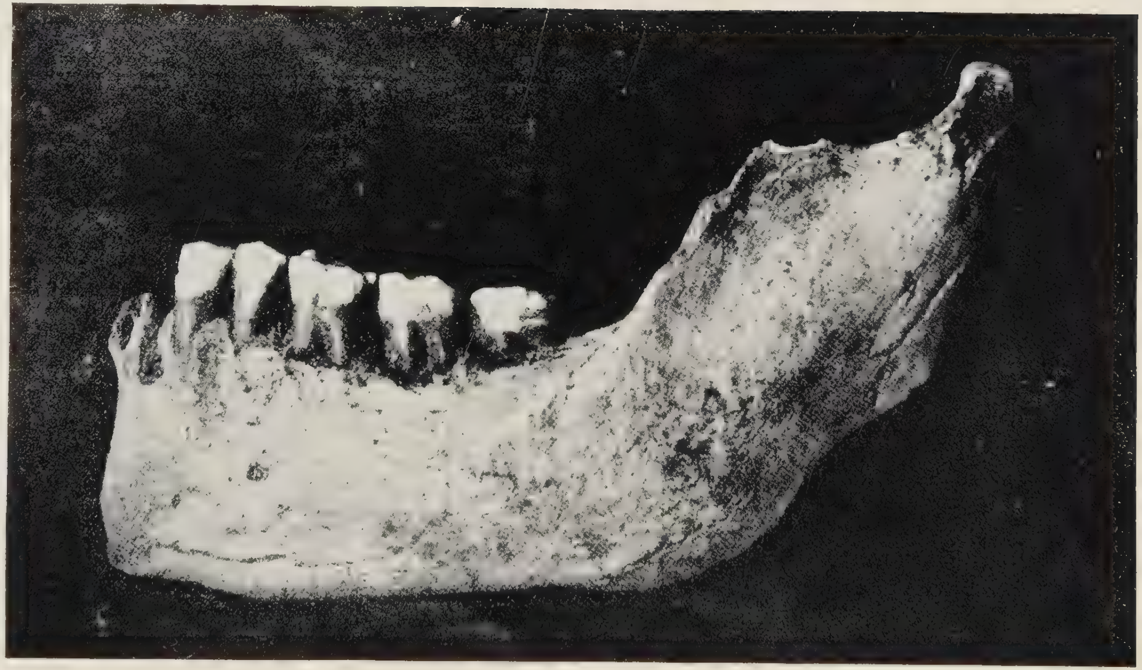
Upper, Dr. Henri Martin in his laboratory at La Quina, 1923.
Lower, a partial view of the La Quina site from the road, 1923.



The La Quina deposits, with the uncovered ancient skeleton. (After Henri Martin.)



The La Quina skull, after reconstruction.



The 1912 La Quina jaw. (After Henri Martin.)

remains of the right bone shows the same characters. The walls of the shaft are stout, particularly posteriorly (anteriorly, near middle, 8 mm.; posteriorly, 11 mm.). On the whole the femora give the impression of relative shortness and robustness. The distinct characters of the femora may be summarized as short, robust, arched, with a distinct torsion, and with but very moderately developed linea aspera.

FINAL REMARKS

(Hrdlička)

The La Quina human skeletal remains are of more interest than has so far been appreciated. While distinctly neanderthaloid they present variants of the type, in the narrowness and lack of massiveness of the adult cranium, in the stoutness of its jaws and teeth, in the primitiveness of the angles of its mandible, in its shallow but long (transversely) glenoids. There is a further variant, an approach to a chin, in the second adult lower jaw. And there is a great deal of interest in the child skull, which on one hand is a Neanderthaler, and on the other, in size, form of vault, and form of occiput, approaches a modern. The majority of the characters of the skull and of the other skeletal parts indicate a submedium male (for a Neanderthaler) and not a female.

There is still much left of the Mousterian deposits of La Quina, taking the classic site alone. The latter is now under the government's protection; it ought to be completely excavated, for there is good promise of still further remains of human skeletons, and such remains would all be of great value.

THE LE MOUSTIER MAN

Still another highly interesting and scientifically valuable skeleton of early man is that of the *Homo mousteriensis* Hauseri. The skeleton is preserved in the addition to the Museum für Völkerkunde at Berlin, where it was seen by the writer in 1923 and again in 1927. It was discovered in March 1908, by O. Hauser, during archeological excavations in what is known as "the lower Moustier cave," or "paleolithic station number 44," at Le Moustier, in the valley of the Vezère, Department of Dordogne, France, and was eventually purchased from Herr Hauser for the Berlin Museum.

The cave, or more properly rock-shelter (fig. 30), when excavated gave numerous evidences of man's occupation, but no human bones. The skeleton under consideration was discovered in the terrace in front of the cave, almost vertically below the entrance. It lay about 3 feet deep and no disturbance in the superimposed deposits was noticeable.

The human bones were uncovered with great care in the presence of responsible witnesses, then covered again with earth and left *in situ* for several months, though shown during this time to a number of visitors. On August 8 they were exposed for Virchow, v. d. Steinen, Klaatsch, and other scientific men, and finally, two days afterwards, in the presence of Professor Klaatsch, they were taken with the utmost precautions from the deposits.

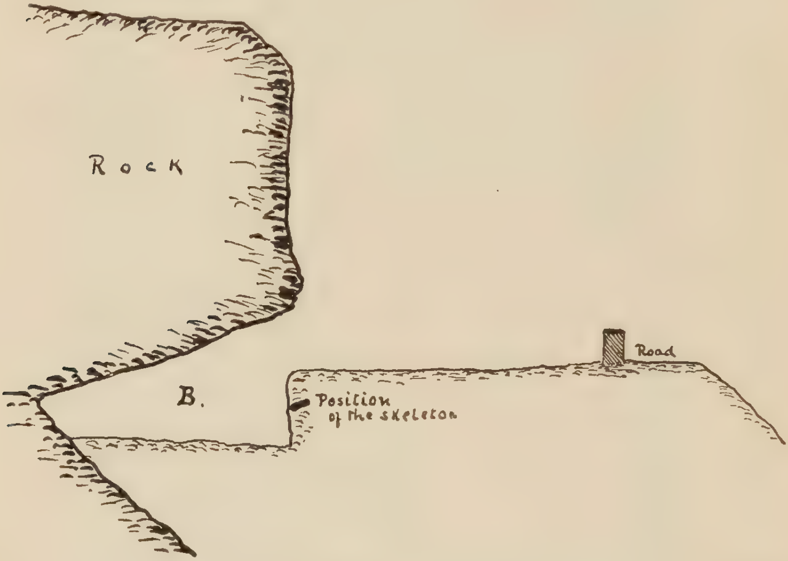


FIG. 30.—The Le Moustier rock-shelter, and the position of the human skeleton. (After Hauser.)

A somewhat picturesque account of the discovery by Hauser will be found in the 1909 volume of the Archiv für Anthropologie.[1] The skeleton, it appears, lay on its side in a natural extended position, with the right hand under the occiput, the left extended along the body. About the body and among the bones were found 74 worked flints, 10 of which were of a well-defined form. On the skull rested a charred bone of *Bos primigenius,* and in the neighborhood of the thorax lay a tooth of the same animal. Besides this, 45 other fragments of animal bones were gathered in close proximity to the human remains. The examination of the human bones was begun on the spot by Klaatsch and continued after the removal of the remains to Germany, resulting in the following conclusions by that author:

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[1] Klaatsch, H., and Hauser, O., *Homo mousteriensis* Hauseri. Ein altdiluvialer Skelettfund im Departement Dordogne und seine Zugehörigkeit zum Neandertaltypus. Archiv f. Anthropologie, N. F., Vol. 7, 1909.

The skeleton belongs to an adolescent of perhaps 16 years of age, probably of the male sex. The height of the boy, as estimated from the long bones, was probably 1.45 to 1.50 m. (4 ft. 9 in. to 4 ft. 11 in.).

The skull, notwithstanding the youth of the subject, shows a number of characteristics which are peculiar to the Neanderthal group. While of good size, with only moderately thick bones of the vault, and the latter of a fair height, it shows nevertheless a rather low and sloping forehead; a well-marked complete supraorbital arch or torus, which later in life would doubtless have become much more prominent; relatively large dental arches, with decidedly large and in a number of particulars primitive teeth; a massive lower jaw with complete absence of the chin eminence; and other interesting features. The glenoid fossae, especially that on the right, show a marked inclination upward and outward, as in the skulls of Krapina and as in the skulls of children in modern man; and there are other characteristics of the skull and skeleton that connect them morphologically quite closely with the man of Krapina.

The long and other bones, as far as preserved, possess numerous primitive characteristics. Especially noticeable among these are the relatively large extremities, particularly the head of the femur; a strong development of the external condyle of the femur; the peculiar arching of the femur; the very marked curvature of the radius; etc. Klaatsch reached the conclusion that the skeleton belongs undoubtedly to the *Homo neanderthalensis* variety of the early European.

During these studies Professor Klaatsch attempted also a restoration of the skull; the first results were, as is well known, unfortunate, but a second restoration proved more successful.

In 1912 the writer saw the originals in the Museum für Völkerkunde, Berlin. They had been purchased from Herr Hauser for a considerable sum, raised, it was stated, through subscriptions led by the Kaiser. After their receipt even the second Klaatsch reconstruction of the skull was recognized to have been somewhat erroneous and so the pieces were taken apart and a third reconstruction was begun by E. Krause, the Museum preparator, with expert assistance. The results were more satisfactory; nevertheless some doubtful points remained even then and these eventually lead to the fourth and the most satisfactory reconstruction of the skull by Dr. Hans Weinert. Dr. Weinert also made a thorough study of the skull, including its measurements.[1]

By this time it was well seen that the Le Moustier skeleton, while representing a much more human-like subject than that of the first reconstruction, and though not adult, was nevertheless a document of human antiquity of much value and importance. Since 1925, the skeleton has lain, in as nearly the original position and environment as it was possible to produce, in a large glass case in the building adjoining the Museum für Völkerkunde, while nearby is a similar case containing the originals of the nearly as important Aurignacian skeleton of Combe Capelle, found also by Herr Hauser.

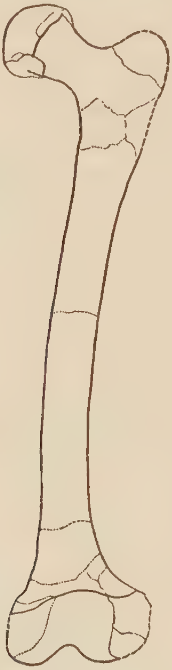

FIG. 31.—The left femur of the Le Moustier youth. (After Klaatsch.)

THE SKULL

Dr. Weinert (1925) in his report on the remains restricts himself essentially to a detailed description, with very complete measurements, of the skull. The work is able and leaves little to be said by other observers. The main conclusions are given in the table below.

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[1] Der Schädel des eiszeitlichen Menschen von Le Moustier, in neuer Zusammensetzung, 54 pp., 38 illustrations, Berlin, 1925.

The skull in all its features fits among the Neanderthalers; those aspects of it that appear more recent are to be ascribed to the youth of the individual. Although it has been suggested that the skeleton may be Acheulian, there is morphologically no indication of anything older than Neanderthal.

A sagittal outline of the Le Moustier skull, contrasted with similar outlines of seven of the Neanderthalers, shows it to possess a lesser supraorbital torus (juvenile), a better arched forehead, a better marked vertex, and a somewhat shorter occiput (pl. 79); but the differences are of very moderate degree and not such as would tend to displace the specimen from the group. A comparison of the outline of the norma superior of the skull with those of Neanderthal and La Chapelle shows similar conditions.

MAIN MEASUREMENTS ON THE LE MOUSTIER SKULL AS FINALLY RECONSTRUCTED

(AFTER HANS WEINERT)

The Skullcap:	cm.
Greatest length from glabella	19.6
Greatest breadth	15.0
Cranial index	*76.53*
Height, basion-bregma	12.85
Height-breadth index	*85.7*
Mean height index (Hrdlička)	*74.3*
Estimated capacity	1,564 cc.
Diam. frontal min.	10.9
Diam. frontal max. near	12.0
Calotte-height (above G-I line)	9.0
Calotte-height index	*47.3*
Endocranial length max	17.6
[Greatest endocranial breadth, near	13.5]
Face:	
Height, total, estimated	12.4
Height, upper	8.0
Diam. bizygomatic	14.5–15.0
Facial index, total, approx	*85.5–82.7*
Facial index, upper	*55.2–60.0*
Basion-alveolar point diam	12.5
Basion-nasion diam.	12.4
[Facial angle	71°]
Maximum diam. of supraorb. arch	12.1
Orbits:	
Height	4.2
Breadth	Uncertain

	cm.
Nose:	
Height, near	5.6
Breadth, near	2.8
Index	*50.0*
Upper Dental Arch:	
Length, near	6.2
Breadth max.	7.4
Bigonial breadth	10.4

LOWER JAW

Bicondylar diam., near	13.3
Length of the bone (Martin "68")	9.8
Height at symphysis	3.0
Height of body at the mental foramen	2.85
Thickness of body, below P1	1.75
Breadth min. of ramus	3.6
Length of upper dental arch	6.32
Length of lower dental arch	6.45

THE SKELETAL PARTS

(After Klaatsch)

Klaatsch (1909),[1] as already noted, diagnosed the Le Moustier remains as those of probably a male adolescent of about 16 years of age. On account of the youth of the individual the measurements of the bones can have but secondary value, unless they could be contrasted with normal modern youths of same age, which is difficult. Many of the parts, moreover, are more or less defective. The main measurements and characterizations of Klaatsch are as follows:

	cm.
Femur, left: Length max., approx	38.0
Shaft cylindrical, its antero-post. and lateral diams. close to	2.5
Extremities relatively large; head large, diams	4.6–4.8
Breadth max. of lower end approx	8.0
Lateral condyle relatively strongly developed.	
Arching forward as in the Neanderthal femur.	
[Also mild arching inward.]	
Linea aspera but slightly developed.	
No platymery.	
Tibia, fragments only:	
Plump, short (not over 29.0 in max. length).	
Not platycnemic.	
Retroflexion of head must have been present.	
Fibula, fragments: stout; resembles that of Spy.	
Humerus, incomplete; Length, estimated	21.0
Strongly developed.	
Deltoid tuberosity pronounced.	
Radius, Strong arching, as in most other Neanderthalers; Length, est.	19.5
Clavicle, Relatively slender, as general in Neanderthalers.	

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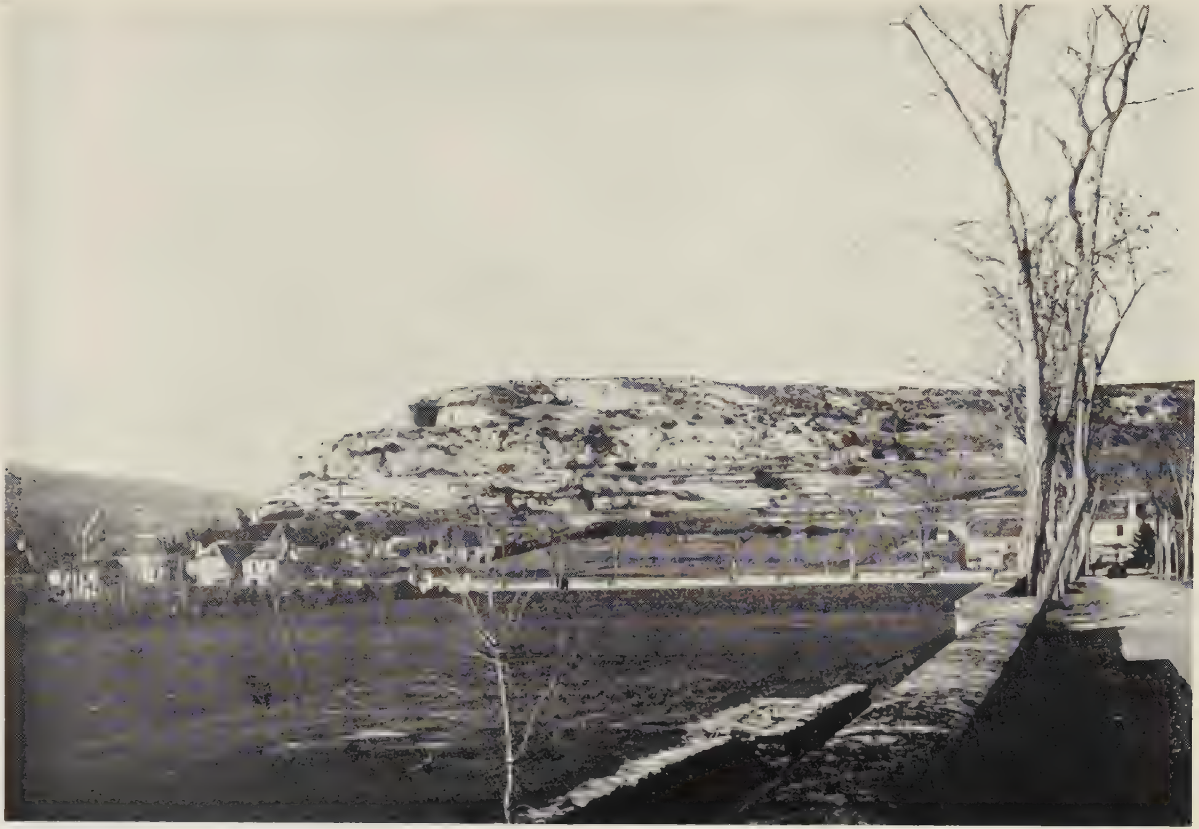
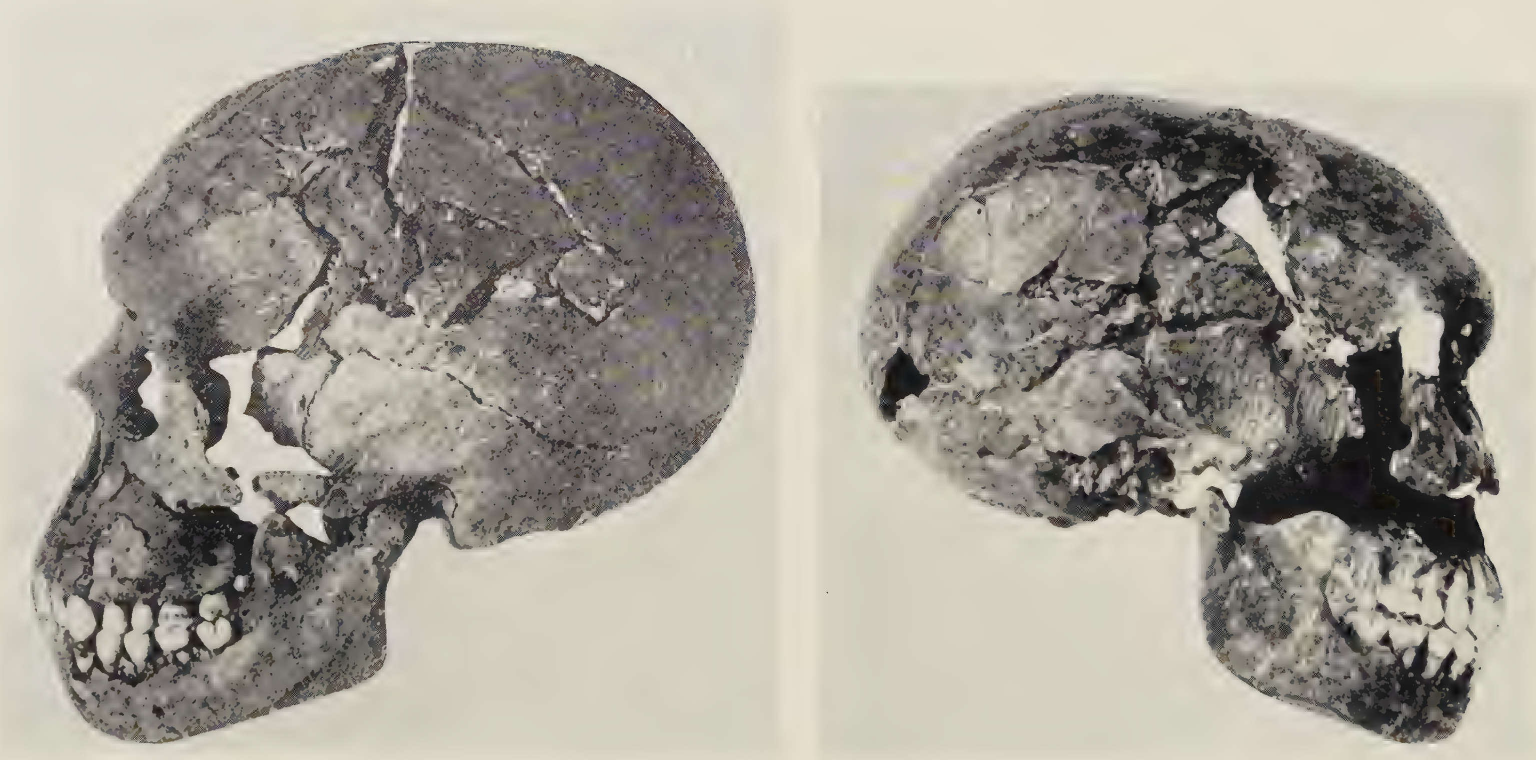
[1] *Homo mousteriensis* Hauseri, etc., pp. 293-294.



Le Moustier, on the Vizère. Upper cave seen; lower shelter, the site of the human skeleton, obscured by the houses. (Photograph by Hrdlička, 1923.)



Skull of the Le Moustier youth.

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THE GALILEE SKULL

In 1925, the British School of Archeology in Jerusalem decided upon the exploration of certain caves in Galilee, and the work was entrusted to Mr. F. Turville-Petre who, during a previous season, had made a preliminary survey of the area. The main site explored by Mr. Petre during the year was what is now often referred to as the " Galilee Cave " and in this cave, at the depth of 6½ feet, towards the lower limit of a paleolithic horizon, were found parts of a neanderthaloid human skull. The main details of the discovery, since published,[1] are as follows:

> Entering the ravine of the Wadi el 'Amud and walking some 150 m. up stream, a cave known as the Mugharet-el-Zuttiyeh is to be seen high up in the cliffs to the north of the stream. The stream at this point is not more than 3 m. wide, and the width of the ravine from base to base of the cliffs might be estimated at about 15 m. The cave, a natural limestone formation, is situated at the base of a precipitous wall of rock, facing southwest; the cliff, which rises to a height of some 20 m. above the entrance, renders it inaccessible from the plateau above;

---

[1] Turville-Petre, F., Researches in Prehistoric Galilee, 1925-1926.

Keith, Sir Arthur, A report on the Galilee Skull. British School of Archaeology in Jerusalem. London, 1927.

while from below, the cave, the modern floor of which lies some 40 m. above the level of the stream, is approached by a steep, rocky slope. . . . .

No flint implements, or other evidence of habitation, were to be seen either on the floor of the cave or on the slope which led up to it, but its size and convenience as a place of habitation, together with the impregnability of its situation, seemed to merit the digging of a trial trench through the débris which had accumulated during generations of use as a stabling for goats.

A preliminary trench was dug from the mouth of the cave inwards to the back wall, running some 2.5 m. northwest of the medial line of the cave. For the first 120 cm. the deposits were of comparatively recent origin, yielding fragments of bone and potsherds, among which Late Roman and Byzantine types predominated, but at a depth of 120 cm., towards the front of the cave, a layer was reached composed of large blocks of rock apparently fallen from the roof, and from below these blocks some fragments of bone in a highly mineralized state were obtained; also a small *coup-de-poing* of Middle Palaeolithic type and a few chert flakes of indeterminate form.

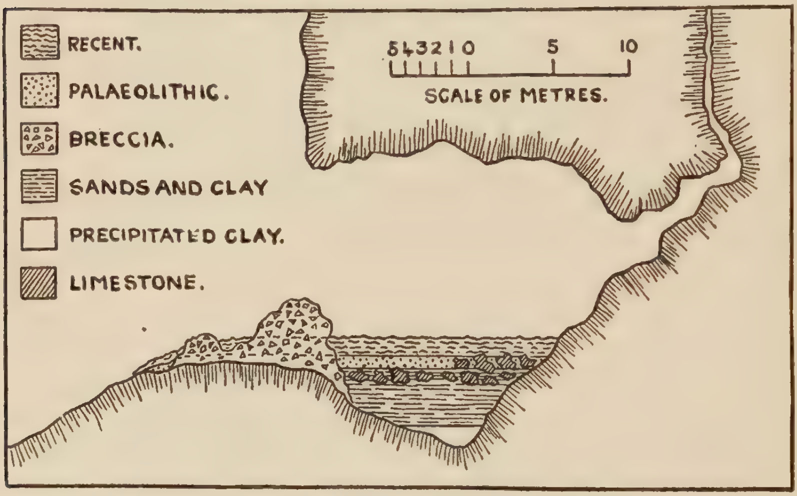

FIG. 32.—The Galilee Cave. (After Turville-Petre.)

The deposits of the cave showed eventually a number of distinguishable layers. The layers of approximately the upper 4 feet showed that the cave had served, latest of all, as a sheep stable; below this and up to about 3½ feet in depth were signs of human occupation extending to early bronze or neolithic period. At a depth of about 3½ feet a layer of fallen rock was found over the central area of the cave.

Below this layer of rock there was a marked change in the character of the deposits. They were here composed of a fine reddish, clayey earth, which was comparatively dry; the bone fragments which they contained were hard and heavy, reddish in colour and gave out a sharp metallic sound when tapped. This layer averaged 90 cm. in thickness, and rested on another consisting of yellowish

> sand, containing water-rolled pebbles. Throughout the layer were blocks of fallen rock, but they never formed a continuous layer, as they had done at a depth of 120 cm. . . . . Fortunately only a small part of the deposits had thus become hardened, and throughout the layer numerous fragments of bone and many worked flints in good condition were found. . . . . No implements were found anywhere above the dividing layer of rock, showing conclusively that the deposits had undergone no serious disturbance since their deposition.
>
> Towards the bottom of this layer of palaeolithic occupation, at a depth of 2 m. below the modern floor level, were four fragments of a human skull. Their approximate resting-place is marked X on the plan. They were lying in a shallow depression formed by irregularities in the cave floor, and were covered by two blocks of rock apparently fallen from the roof. The frontal bone has been separated from the skull to which it originally belonged along the line of suture, but there is nothing to indicate that the separation was produced by force, or least of all to suggest that the individual may have been killed by the fall of the rocks beneath which the fragments lay. Nor was there anything in the position of the bones and arrangement of the blocks of rock to suggest an intentional burial. It is difficult to surmise what may have become of the rest of the skull. Careful sieving of all the earth taken from the surrounding area and from numerous other parts of the layer failed to disclose any further human remains. The fact that the four fragments, namely the frontal bone, part of the right zygomatic bone, and two fragments of the sphenoid, were all found together, indicating that they have become separated since reaching their final resting-place, seems to preclude the probability of their having been washed into the cave from outside, for in such a process the projecting sphenoid portions would almost inevitably have become detached; nor is it possible that they could have fallen through from a higher level, for if so, how did they come to lie beneath two large blocks of rock, themselves entirely covered by palaeolithic deposits? The bone itself is in a hard, highly mineralized state, extremely heavy and reddish in colour, in fact in every way similar to the other bone fragments found in the layer; it differs absolutely from the soft light pieces of a yellowish colour found in the superior layers.

In 1926 the work in the cave was finished, without further discoveries of note. Sections through the water-laid deposits below the paleolithic layer showed no earlier traces of occupation, human or animal.

The fauna recovered from the paleolithic layer, as determined by Miss Bate, was in the main as follows:

Hippopotamus sp.
Bison or *Bos*
Equus sp.
Ursus cf. *arctos*
Hyaena cf. *striata*
Hyaena crocuta
Sus sp.
Vulpes cf. *nilotica*
Felis cf. *pardus*
Felis cf. *sylvestris*
Felis chaus
Hystrix sp.
Cervus sp. (*C. elaphus* group)
Dama mesopotamica
Gazella arabica
Gazella sp.
Capra primigenia
Capra sp.

The stone implements, of flint and chert, show essentially Mousterian affinities. There are also, however, some short and long blades and a few other implements that resemble somewhat later types.

> Among the specimens collected from the lowest layer of the Zuttiyeh Cave in 1926 there are a number of fragments of antlers and of limb bones of ungulates, bearing incisions and markings which are of considerable interest. Some of the markings may be the result of gnawing by Carnivora or Rodentia, but others cannot be accounted for in this way. . . . .
>
> One of the most interesting facts disclosed by the study of the animal remains from the Emireh and Zuttiyeh Caves is the definite association of *Hippopotamus* with a Middle Palaeolithic culture, and the probable association of *Rhinoceros hemitoechus* with a slightly later culture. This seems to point to the fact that there has not been any great faunal change in this region between the Mousterian and the following period. The fact that this rhinoceros is *R. hemitoechus* and that this species also occurs in Syria is highly important, emphasizing the absence of evidence of a so-called cold fauna.
>
> Below the Middle Palaeolithic occupation layers of the Zuttiyeh Cave "African" types are represented by the spotted hyaena (*H. crocuta*) and perhaps by a river hog (*Potamochoerus*); these were associated with a large form of brown bear (*Ursus arctos*), a typically Palaearctic animal.

DESCRIPTION OF THE SKULL

The Galilee skull fragment and its endocranial cast have been studied ably and ingeniously by Sir Arthur Keith.[1] The writer saw the original in 1927, and has since been able to obtain a good cast of the specimen, together with that of the endocranium. The parts present include the whole frontal, upper parts of the nasals, most of the right malar, and most of the right sphenoid. The frontal and sphenoid show separation at the sutures, indicating on one hand a young person (in the opinion of Sir Arthur Keith probably under 25 years of age), and on the other a separation of the missing parts before the remains reached the place where discovered. As to sex, Sir Arthur inclines to attribute the bones to a female, the writer to a not very robust male. The bones are well preserved, of dark red color, and highly petrified.

The features are those of the Neanderthal type. There is a stout, but very distinctly bi-arched supraorbital torus. With the striking protrusion of the torus goes also that of the glabellar region, yet the glabella remains behind so that it is located in a marked depression between the ridges, more marked than in any of the other Neanderthalers. The tori (for we must speak of two in this case) are stoutest in their mesial two-fifths, especially on the right (on cast r., 17; l., 15.5 mm.). More distally, from about their middle, the tori are flattened from above, but not tapering. Above and behind the tori, as is usual with this conformation, is a marked depression, though with no semblance of the anthropoid medial prefrontal shelving and fossa.

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[1] Report on the Galilee Skull; in the joint Memoir, pp. 52-106.

The forehead is rather narrow (diam. front. min. 9.7 cm.), but better arched than in most of the Neanderthalers and less sloping. From side to side it shows a uniform convexity. It gives indications that the skull was dolichocephalic (diam. front. max. 11.3 cm.) and fairly high, higher relatively than most of the Neanderthal crania.[1] The frontal squama is about as thick (5-7 mm., Keith) as in stronger modern male skulls; in this respect it is much like the La Quina skull and near to Krapina C, but exceeded by other Neanderthalers. The surface of the squama shows three scars, one rather deep, caused probably by injuries in life. The temporal crests are about as in modern skulls. The coronal suture was fairly well serrated.

The endocranial surface shows a strong metopic ridge. The lower half of the squama presents numerous though mostly shallow impressions of brain convolutions, some at least of which can be identified with similar depressions in modern skulls. The inferior frontal-most region gives the impression of being somewhat more cramped, not as filled out, and slightly more beaked, than it generally is in modern crania; yet the actual dimensions of the anterior cerebral fossa in length, breadth, and height are much like those in similarly shaped recent skulls. The marked depression and exposure of the cribriform plate of the ethnoid on each side of the rostrum that are seen in most modern skulls, appear to have been much less marked in the Galilee specimen. The remaining anterior (sphenoidal) portion of the temporal fossa shows much the same size, shape, foramina, and impressions as a dolichocephalic white skull used for comparison.

The facial parts and the whole frontal as well as general aspect of the fragment give a slightly feminine reflection, and Sir Arthur Keith's inclination to regard the skull as feminine can readily be understood; but the great supraorbital tori cannot possibly, in view of comparative evidence on the two sexes in apes and of the ontogenetic as well as all racial evidence on the torus in man, be attributed to a female. The student is confronted here with the same difficulty as in the cases of the Spy 1, La Quina, and Ehringsdorf specimens. That the paleolithic female conformed to the rule of lesser development of the tori, is well seen in the middle aged female of Gibraltar, as it is seen also in those of Předmost, Obercassel and Grimaldi. A great development of the supraorbital tori is one of the most dependable of male characters, and no skull with such tori can possibly be definitely identified as a female without a most convincing proof of the accompanying skeleton. It is well known that male skulls with more or less female aspect occur among all peoples, and such a female " reflection " would be heightened in skulls of young adults; just as a good male skull may be accompanied by a weak, more or less female-looking skeleton. It is for these reasons that the writer cannot but regard the Galilee skull, just as those of the La Quina and Ehringsdorf, as young masculine.

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[1] "In height of vault the Galilee skull resembles modern skulls; it was not low and flat-domed as is the case in all typical examples of Neanderthal skulls." Keith, *ibid.*, p. 62.

To return to the description: The nasal process of the frontal bone is stouter than in modern crania (min. interorbital breadth close to 2.7 cm.), though less stout than in most of the Neanderthal skulls.

The orbits approached irregularly quadrangular, were megaseme, and deep, but not large (right, h., 3.7; br. 4.0) than in large-orbited modern crania. They lack the striking subhuman aspect shown in the Gibraltar skull. The borders are dull all over. Their vertical plane, notwithstanding the great protrusion forward of the tori, is nearer modern, due to the fact that the whole orbital and suborbital region is well forward in this skull; and the lateral inclination of their plane is even less than in many skulls of whites, due to the relatively backward position of the nasion and forward position of the frontal process of the malar.

The nasion is considerably more backward than the glabella; it is situated but slightly above the middle of a transverse line connecting the intersection points of the borders of the orbits and the malo-frontal sutures, or much as in modern crania. The nasal bones were fairly broad and strong. The root of the nose is rather low, moderately and uniformly convex from side to side. It is near that of the average negro, but could be duplicated in many non-European and even some European modern skulls.

The malar bone is not far from that in some modern skulls; it could perhaps best be described as intermediary between the more typical Neanderthal form and that of modern man. The body is not large, yet not smaller than in many white males; the frontal process is decidedly stouter and broader than in European skulls of today, but not as stout or broad as in most of the Neanderthalers; and there was no masseteric protrusion of the lower border. But there is a well marked inferior swelling of the bone, corresponding to what could be described as a moderate prominence of the region in modern Europeans. The bone forming the malar is throughout somewhat stouter than in modern whites. A portion of attached maxilla indicates a considerably broader alveolar arch than in modern Europeans. The whole face was broad in relation to the vault. The nose also doubtless was broad.

An interesting condition is seen posteriorly to the external malarofrontal boundary of the face, as to the post-orbital and alisphenoidal region. This area is much more spacious than in modern whites, owing to the much greater breadth of the orbital plate of the malar and of the greater wing of the sphenoid. The smallest distance between the external border of the frontal process of the malar and the spheno-temporal suture, is (on the cast) 32 mm., the corresponding distance in modern whites oscillating about 20 mm. This meant a large space in the Galilee skull for the temporal muscle, indicating a heavy and large lower jaw with large teeth, as is usual in the Neanderthalers. The sphenoid bone shows some strange conditions in the pterygoid region, but these look abnormal; they are dealt with in detail by Sir Arthur Keith.

PRINCIPAL MEASUREMENTS OF THE SKULL

(After Keith)

Max. transverse breadth of torus	11.9 cm.
Thickness of torus	12.0 mm.
Diam. frontal min	9.7 cm.
Diam. frontal max	11.3
Max. breadth of the skull (estimated)	13.8
Nasion-bregma diam.	11.3
Orbit (r.) height	3.7
breadth	4.0
Index	*92.5*

CONCLUDING REMARKS

There can be no doubt about the Galilee skull belonging to the Neanderthal group; but many points, including the accompanying industry as well as the fauna, indicate that it belongs probably well forward in this group. Morphologically, the shape of the forehead, the height of the vault, the size and form of the orbits, and other characteristics, as well as the general features of the brain, point towards later man, while there is yet enough to connect the specimen with the far past.

Explorations in Palestine, thus auspiciously initiated, will continue; some new undertakings are in fact now (early in 1929) under way under the leadership of Miss Garrod; and Palestine, with other parts of Asia Minor, may give much that will complement, and perhaps help us to better understand, conditions in western Europe.

THE ROME SKULL

The specimen was found by laborers, in April, 1929, in a breccia-filled cave, located about 3 km. from the Porta Pia. It was extracted by the foreman and placed by the owner, Duke Grazioli, in the Anthropological Institute of the University at Rome. The skull was embedded in the breccia and before it was recognized it was damaged by the workmen, particularly in the most interesting region, that of the supraorbital arch, of which nothing remains. The lower jaw is missing.

A preliminary study of the specimen by S. Sergi[1] indicates that it is the skull of a female about 30 years of age, of cranial capacity not exceeding 1,200 cc., with low vault, relatively large size of the facial parts compared to the brain case, and marked total facial prognathism. In general the skull shows the well-known Neanderthal type; the third molars, however, are smaller than the first and second (which are equal).

The cave and the further undisturbed site of the find were carefully examined. The breccia filling the cave is of alluvial origin. It has yielded in the course of the excavations various bones of extinct animals, including *Elephas antiquus, Hippopotamus major, Rhinoceros merckii, Cervus elaphus, Bos primigenius,* and others. There are no worked stones. The human skull proceeds in all probability from an individual coeval with these forms. The age of the breccia and its contents is referred to as mid-Quaternary and last (Riss-Würm) interglacial, which seems incongruous, but is connected doubtless with some local views of the ice period.

THE LA NAULETTE JAW

The La Naulette jaw was found in 1866 by Edouard Dupont in the cave of La Naulette, Belgium, together with an ulna and a few other fragments of human bones. The find was reported and the bones described by Dupont in the Bulletin de l'Académie Royale de

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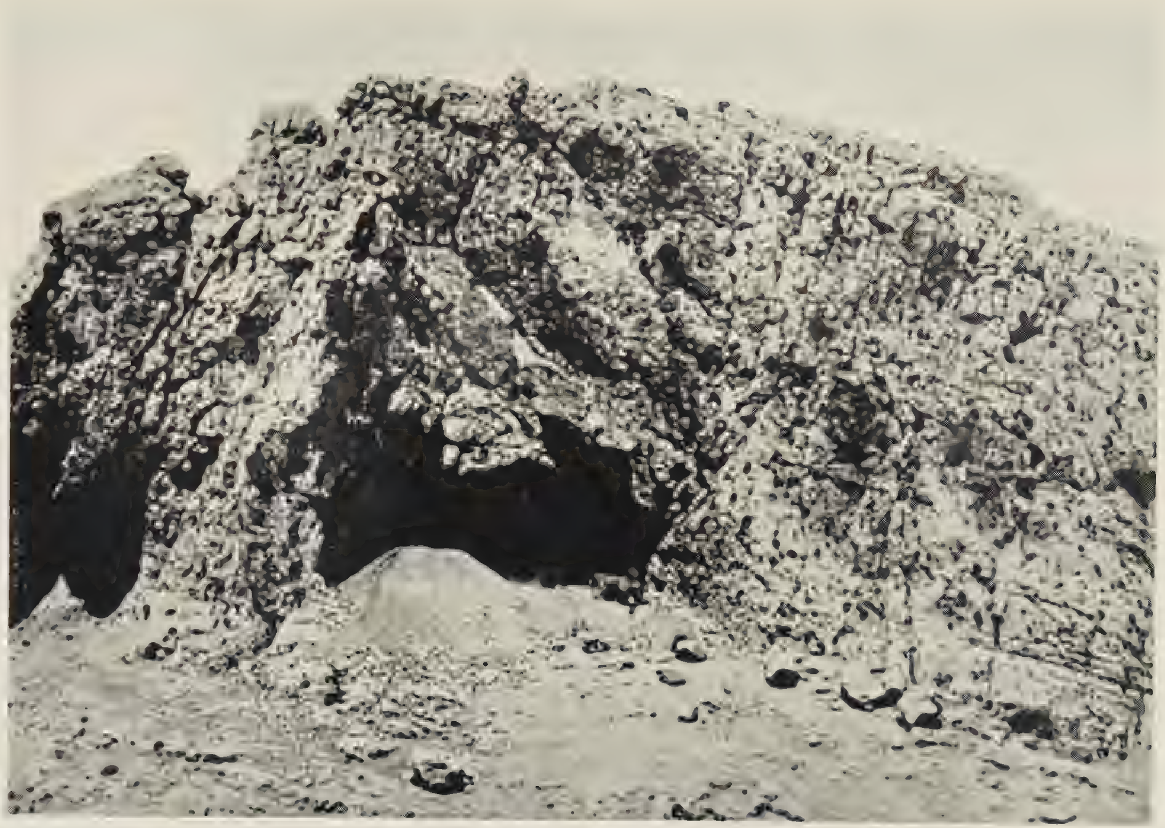
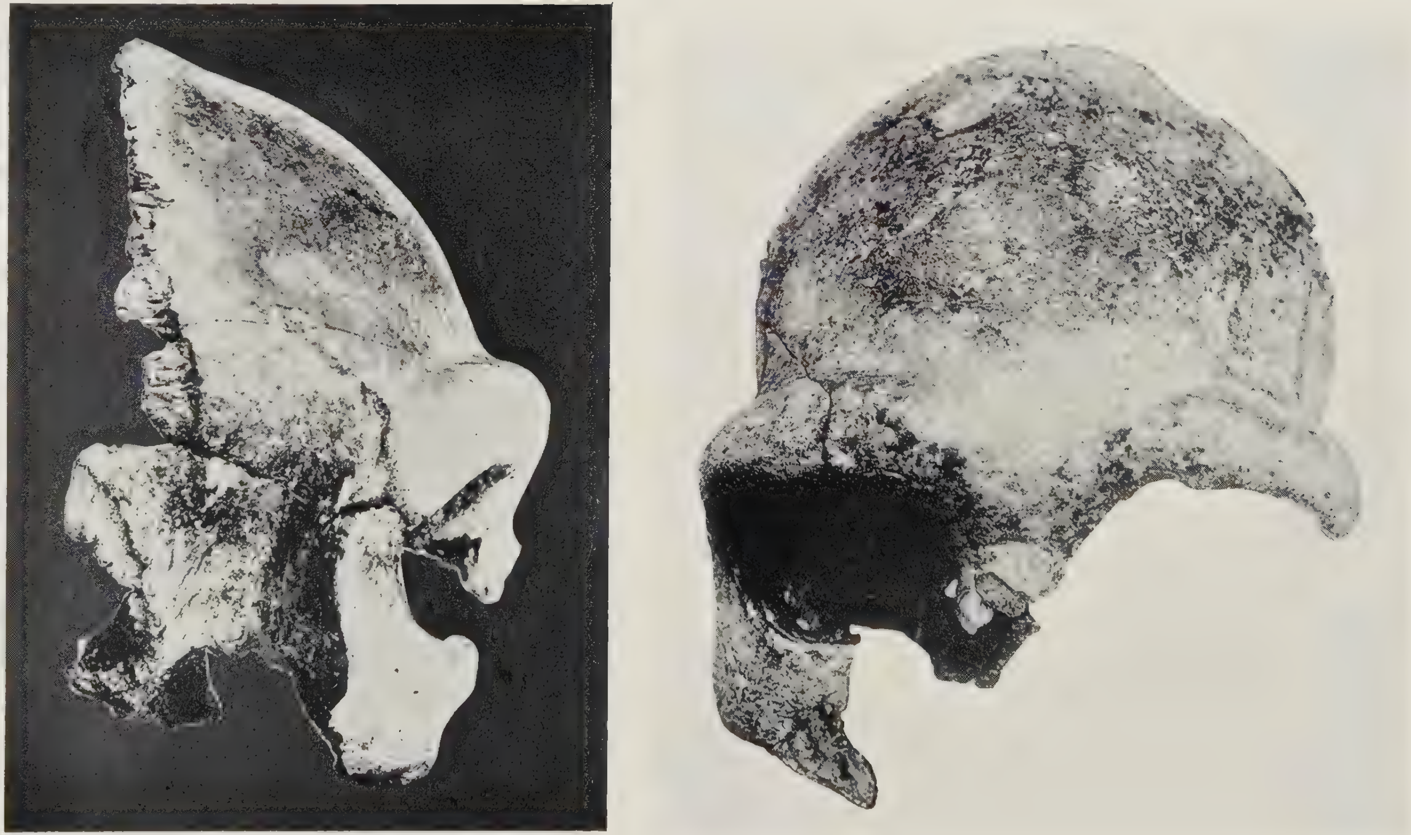
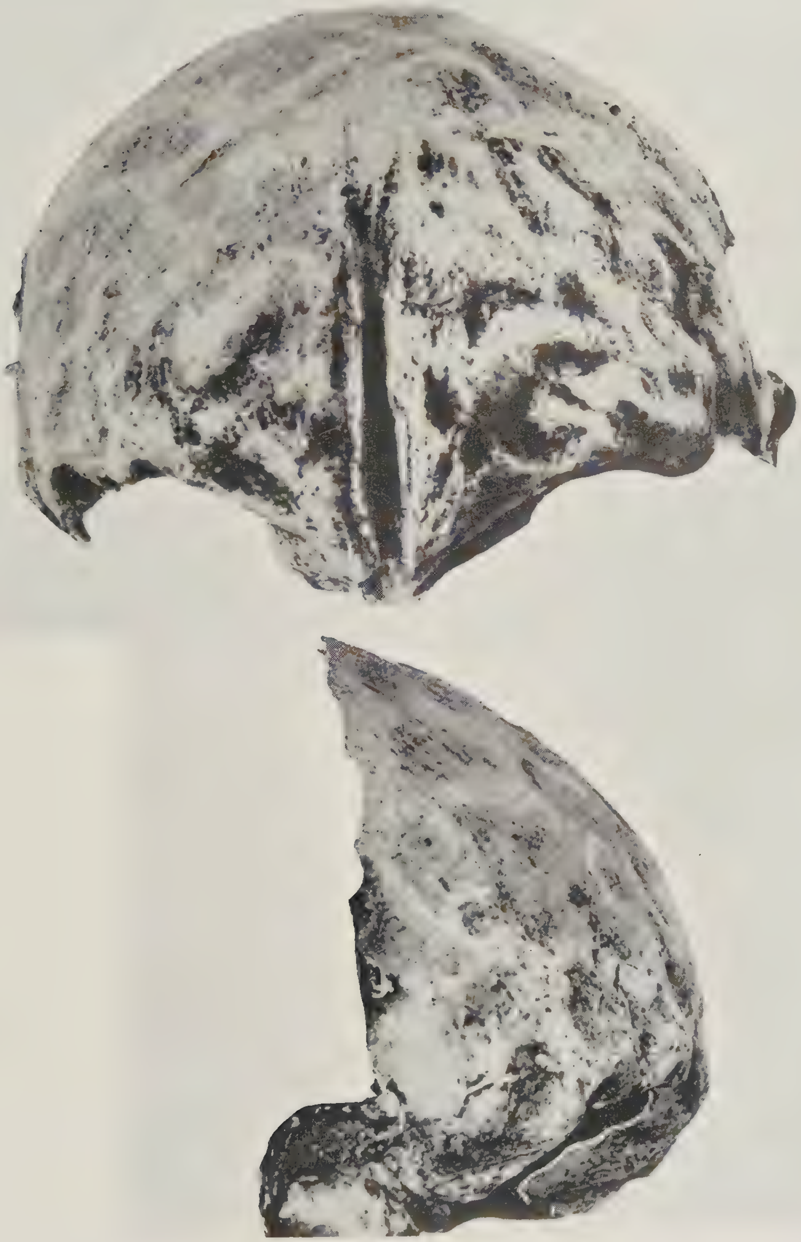
[1] Discovery of a cranium of Neanderthal type near Rome (in Italian). By Sergi (S.)—Riv. Antrop., 1929, Vol. 28; repr. 9 pp., 2 pls.



The Galilee cave. (After Turville-Petre, 1927.)



The Galilee skull. (After Keith.)



Endocranial cast of the Galilee skull. (After Keith, 1927.)

Belgique, 1866,[1] and by Topinard in the Révue d'Anthropologie of the same year.[2] The original specimen is preserved in the Musée Royal d'Histoire Naturelle, Brussels.

The large cave of La Naulette is located in the bluffs of the left side of the beautiful Lesse river, not far from Dinant, Province of Namur. The opening of the mouth is situated at present 25 m. (nearly 80 ft.) above the river. The interior of the cave measures more than 60 m. in length by an average of 10 m. in breadth. The deposits in the cave were 11 m. in depth, but this included a considerable top layer of rock fall and débris. Between the layer that gave the human jaw and the surface there were four separate stalagmitic strata.

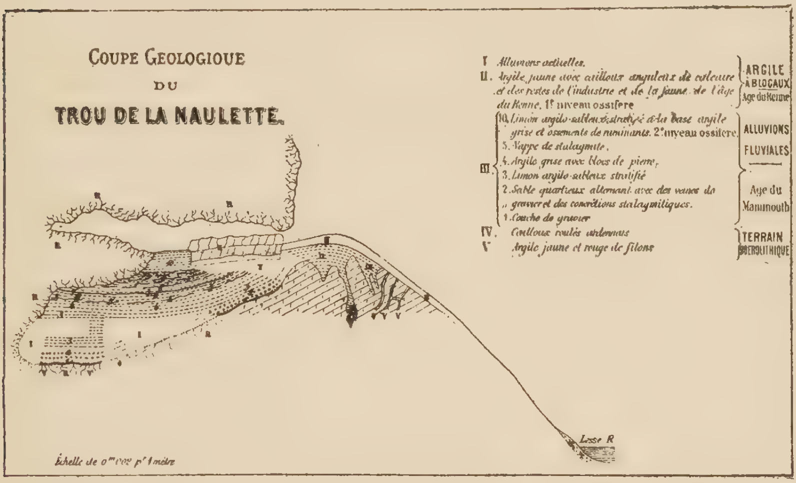

Coupe Geologique
du
TROU DE LA NAULETTE.
I Alluvions actuelles.
II. Argile jaune avec cailloux anguleux de calcaire et des restes de l'industrie et de la faune de l'âge du Renne. 1er niveau ossifère
III
10. Limon argilo-sableux stratifié à la base argile grise et ossements de ruminants. 2e niveau ossifère.
5. Nappe de stalagmite.
4. Argile grise avec blocs de pierre.
3. Limon argilo-sableux stratifié
2. Sable quartzeux alternant avec des veines de gravier et des concrétions stalagmitiques.
1. Couche de gravier
IV. Cailloux roulés ardennais
V. Argile jaune et rouge de filons
ARGILE À BLOCAUX
Age du Renne
ALLUVIONS FLUVIALES
Age du Mammouth
TERRAIN
Lesse R.
Échelle de 0m 002 pr 1 mètre

FIG. 33.—The La Naulette Cave and its deposits. (C. R. Congr. préhistor.)

The fauna in association with which was found the human jaw comprised the following forms:

Mammoth
Woolly Rhinoceros
Brown Bear
Horse
Reindeer
Wolf
Fox
Boar
Deer
Badger
Marmot
Chamois
Mouflon (probably)
Water Rat (Arvicola)
Bat
Fish

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[1] Vol. 22, p. 44 *et seq.*

[2] Les caractères simiens de la mâchoire de la Naulette. Rev. d'Anthrop., Vol. 9, pp. 385-431, 1866.

The ossiferous layer lay 4.55 m. from the surface and was 0.60 m. in thickness. Beneath it were sterile layers of gravelly sand and clay. In addition to the human lower jaw and ulna there was also found in the ossiferous layer an animal bone with a neatly made artificial perforation. There is no mention in the report of any stone implements.

A final report on the exploration of the La Naulette cave, accompanied by a chart showing the deposits, was made by Dupont in 1867.[1] He reached the conclusion that the two human bones were in all probability introduced in the cave by man himself and that they were the remains of cannibalism. He also states definitely that notwithstanding a most careful search, no worked stones nor any remains of fireplaces were found in the cave; there were, however, intentionally broken animal bones indicating human activity.

After having submitted the human remains to various experts, Dupont proceeds to their description, and then gives the following measurements:

	mm.
Height at chin	31
Height at M2	22
Thickness at chin	15
Thickness at last molar	16

The ulna is also briefly described by Dupont (*ibid.*). He tells us that the bone, the head of which is missing, shows a "normal" form; that it belonged to an individual of small height; and that its aspect as well as proportions indicate that it proceeds from a female skeleton, from which also may have come the lower jaw. The lower jaw was studied intensively by Topinard, and since then more or less by most other workers in human Prehistory.

In 1923, thanks to Professor A. Rutot, Director of the Musée at Brussels, the writer was able to examine the original. The specimen comprises the frontal part and left body of the jaw. It is a normal bone of primitive build. It belonged to an adolescent female; the socket for M3 indicates that the tooth had not yet fully erupted. It resembles closely the female lower jaws of Krapina.

The bone is stout, especially for a female; at the same time the body is low, indicating the female sex. The symphyseal region is nearly flattened from side to side between the elevations of the canine roots, as in other Neanderthalers, and is quite perceptibly receding; nevertheless there is a mild eminence of a chin. The mental foramen is located beneath Pm2.

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[1] Étude sur cinq cavernes explorées dans la vallée de la Lesse et le ravin de Falmignoul pendant l'été de 1866. Bull. Acad. Roy. Belgique, Vol. 23, p. 244 *et seq.*, 1867.

Inferiorly the bone shows the usual neanderthaloid broad surface for the attachment of the digastrics, with a rather marked submental or platysmal (H. Virchow) spine; but the surface is not as flat as usual in Neanderthal jaws, thus approaching somewhat more closely recent conditions.

Lingually, anteriorly, there is a fairly marked shelving from above, mildly concave below the incisors, convex below the premolars. Inferiorly this shelving is bounded by a marked dull transverse ridge, the well known epimedial torus of early jaws. In the median line a slight ridge extends from the posterior part of the septum between the middle incisors to the middle of the torus, thus dividing the depression below the incisors into two lateral shallow fossae. This vertical ridge does not extend any further downward.

Beneath the torus is a rather marked median depression, corresponding to the anthropoid fossa in this location, without any clear trace of the genial tubercles. Below this depression is another stout dull ridge or rather a bilateral welt, into which merges on each side the much less pronounced mylohyoid ridge. All these conditions are much as in other Neanderthalers, with some individual variations. Below the mylohyoid ridge the body of the bone is full, with but a very faint depression, in this respect approaching modern conditions and differing markedly from most of the early jaws, in which there are pronounced depressions.

The teeth were macrodont, the roots of the incisors and canines being thick antero-posteriorly. The alveoli of the canines are considerably larger than those of the incisors or the neighboring premolars. The alveolus of the posterior premolar on the left side shows a three-quarter version of the tooth on its axis, so that the latter instead of being transversal is directed somewhat obliquely forward. The alveoli of the three molars show a distinct increase in size from before backwards.

On the whole the jaw is clearly that of an early man and is classified with the Neanderthal type of lower jaws.

PRINCIPAL MEASUREMENTS

(Mainly After Topinard)

	mm.
Height at symphysis	31
Height at M2	23
Thickness max. at symphysis	14.5
Thickness at M2	16

ADDITIONAL LITERATURE

Blake, C. Carter. On a human jaw from the cave of la Naulette, near Dinant, Belgium. Anthrop. Review, July and October, p. 295, London, 1867.

Broca. Discussion, même séance, p. 593.

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De Quatrefages et Hamy. Crania ethnica, p. 23, 1875.

Dupont, Edouard. Étude sur les fouilles scientifiques exécutées pendant l'hiver de 1865-66 dans les cavernes des bords de la Lesse. Bull. Acad. Roy. Belgique. Vol. 22, pp. 31-54, 2 pls., 1866.

———. Étude sur cinq cavernes de la vallée de la Lesse et le ravin de Falmignoul pendant l'été de 1866. Bull. Acad. Roy. Belgique, Vol. 26, p. 244 *et seq.*, Avril, 1867.

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Pruner-Bey. Sur la mâchoire de la Naulette. Bull. Soc. Anthr., Paris, Vol. I, p. 584, 1866.

———. Discours sur la question anthropologique. Congrès internat. d'Anthrop. et d'Arch., p. 352, Paris, 1867.

Topinard, P. Les caractères simiens de la mâchoire de la Naulette. Rev. d'Anthrop., Vol. 9, pp. 385-431, 1886.

THE ŠIPKA JAW

The Šipka specimen is a fragment of the lower jaw of a child, probably between eight and ten years of age. It was found in 1880 in the Šipka cave, near Štramberk, Moravia, by Prof. Karel J. Maška, the Moravian explorer. It shows six teeth—three incisors, the right canine, and the two right premolars, the three last named not yet erupted. In 1912 the original of the Šipka jaw was still in the care of the discoverer at Telč, Moravia, where it was seen by the writer.[1] Since then Professor Maška has died and the specimen has come to the "Zemské Museum" of Moravia, at Brno.

The extensive but largely obstructed cave after laborious cleaning showed several (up to 8) distinct layers of paleolithic human occupation with many traces of fire. Its exploration was carried on by Maška from 1879 to 1883, without exhausting the deposits.

The lower jaw was found on August 26, 1880, near the entrance of a so-called "badger-hole," a small side cavity. It lay in an undisturbed layer of ashes in the lowest cultural deposits of the cave, close to

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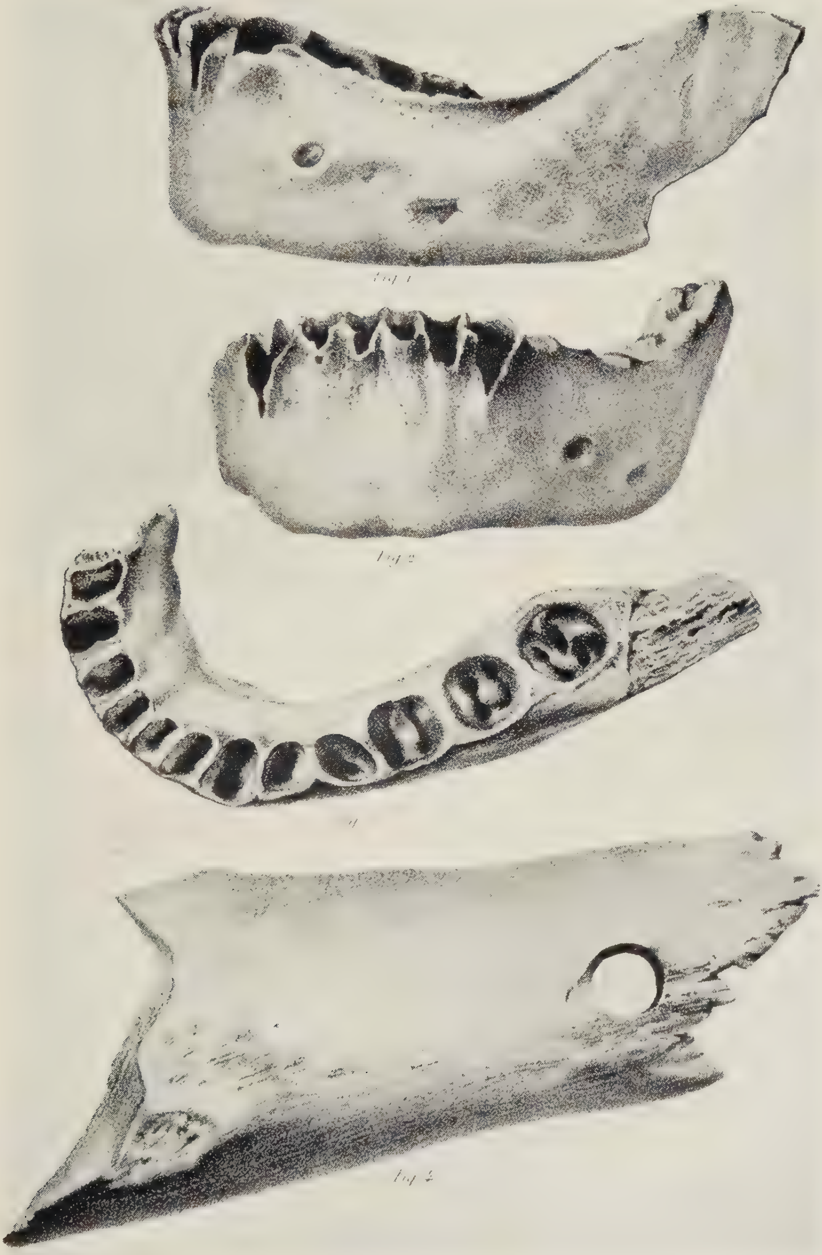
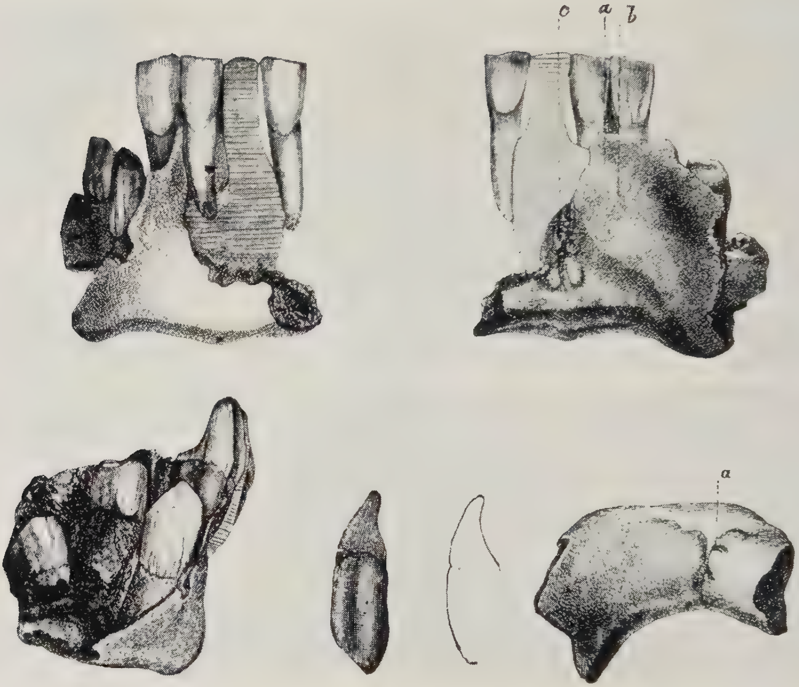
[1] Schaaffhausen, H., Ueber den menschlichen Kiefer aus der Shipka-Höhle bei Stramberg in Mähren. Z. Ethnol., Vol. 40, pp. 279-309, 1882.

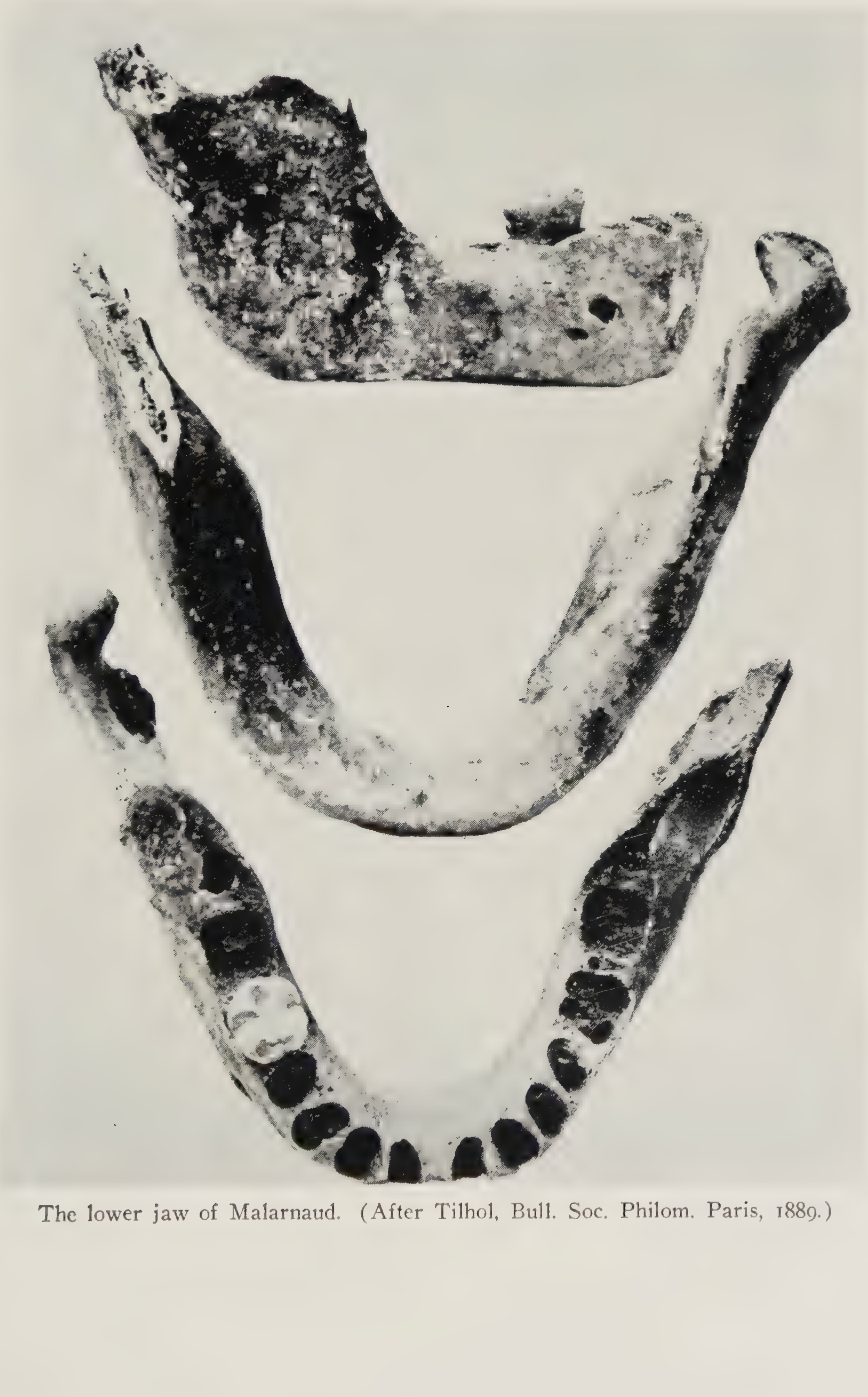
A detailed description of the Šipka cave (with others) and of the jaw, with the earlier literature on the find, is to be found in Maška, Karel J., Der diluviale Mensch in Mähren, Neutitschein, 1886. Later references are included in the various textbooks on prehistory.



The Naulette jaw, and a perforated (drilled) bone found in the same deposits.
(After E. Dupont, Bull. Acad. Belgique, Vol. 22, pl. 1, 1866.)

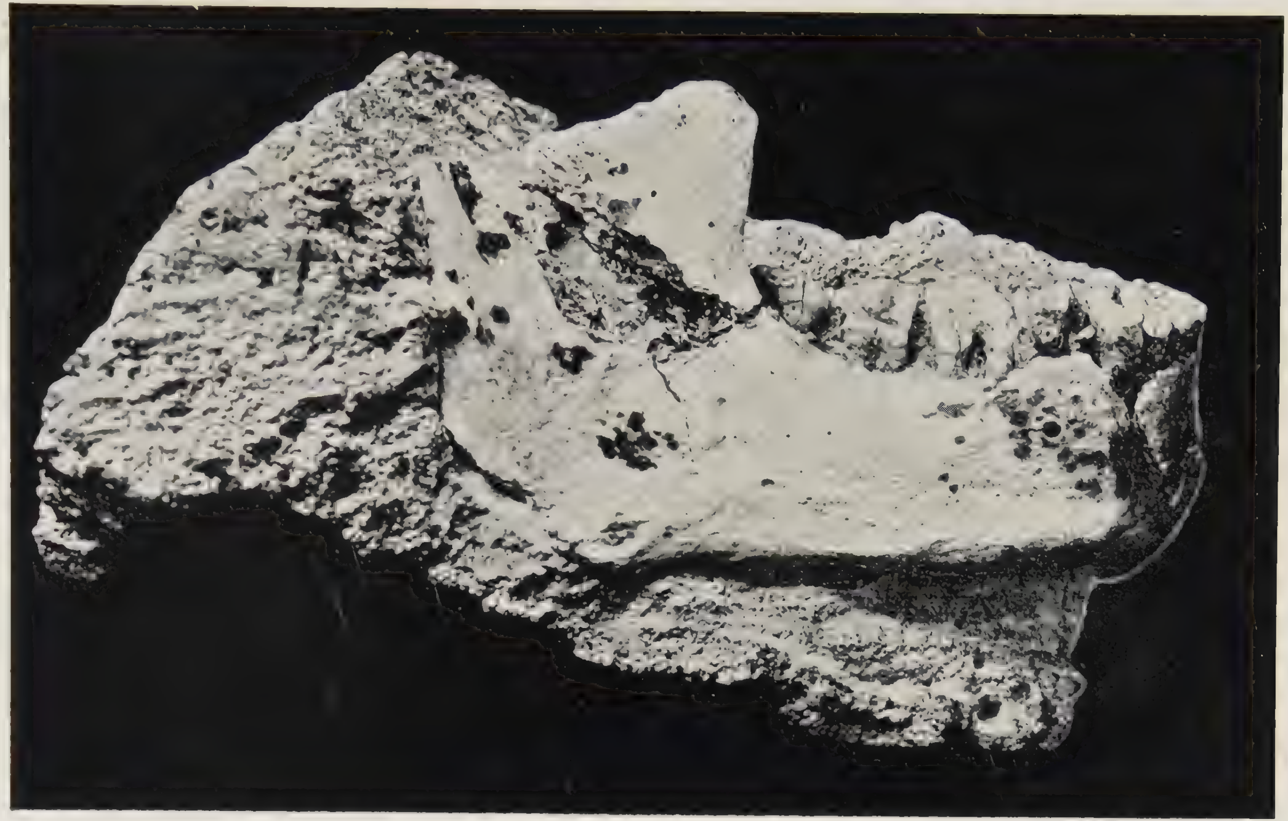


The jaw of Šipka, Moravia. (After K. Maška, 1886.)



The lower jaw of Malarnaud. (After Tilhol, Bull. Soc. Philom. Paris, 1889.)

The calcareous tufa quarry near Bañolas, from which the human jaw was recovered. (After Pacheco and Obermaier.)



The Bañolas jaw, right side. (After Pacheco and Obermaier.)

the wall of the hole, at the depth of 1.4 m. (4½ ft.). It was enclosed in a clump of hardened ashes. Nearby and in the same layer elsewhere were quantities of bones of diluvial fauna, elephant (sp.), *Rhinoceros tichorhinus,* lion, leopard, cave lion, cave hyena, cave bear, brown bear, bison, wolf, horse, elk, reindeer, etc.

The stone implements of the lower cultural layer (which enclosed the human jaw) are almost all of quartzite, and of crude workmanship, on the whole related to the Mousterian. Professor Maška's conclusions were that the cave showed human occupation that extended over a large part of diluvial time; that this occupation showed three distinct though not wholly disconnected horizons, the lowest of which gave the human mandible.

The jaw itself is regrettably only a fragment of the chin with six teeth. The bone is both larger and stouter than in a modern child, and shows various primitive characters; and the teeth are decidedly large. The symphyseal part was evidently somewhat receding, though there is a slight indication of a chin eminence; the inferior border of the anterior region of the jaw shows the cupid's bow outline, as it does in the lower jaw of Mauer and more or less in those of the Neanderthalers; the inferior border itself is broad and flattened, as is general in Neanderthal mandibles; lingually the bone apparently shelved backward; and there are other peculiarities.

The writer has twice seen the original. The specimen makes a strong impression of primitiveness, and of a general relationship with the lower jaws of the Neanderthalers.

THE MALARNAUD JAW

The lower jaw of Malarnaud was discovered in 1889 in a small side chamber of the cave of Malarnaud, near the village of Montseron, Arize, France. It lay 2 m. (about 7 ft.) deep beneath a layer of stalagmite, in a mass consisting of reddish clay and a great quantity of bones of Quaternary animals. The fauna was characterized by mammoth, *Rhinoceros tichorhinus,* the cave lion, cave hyena, and cave bear.

The bone itself is that of an adolescent, the third molars being still in their sockets. The erupted teeth are missing, with the exception of the first right molar. The jaw is not of great size and is rather low but stout. Like the La Naulette specimen, it shows a somewhat receding chin though with a slight indication of chin eminence.[1]

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[1] For original descriptions of the find, see Filhol, H., Bull. Soc. Philomath. Paris, 1889, and Congrès Anthrop. préhist., p. 417, 1889. Boule, M., La caverne de Malarnaud; *ibid.;* also in his Fossil Men, p. 183, 1923.

THE BAÑOLAS JAW

The lower jaw of Bañolas was found in April, 1887, by Señor Pedro Alsius, a druggist of the town of Bañolas, which lies on the eastern bank of the Lago di Bañolas, about 23 km. to the NNW of Gerona, in the northeastern part of Spain. The bone was found in a block of limestone proceeding from an open quarry of calcareous tufa, a short distance to the north of the town of Bañolas. The block of stone had been broken off by the quarrymen, who saw in it indications of a row of teeth and notified the druggist of the occurrence.

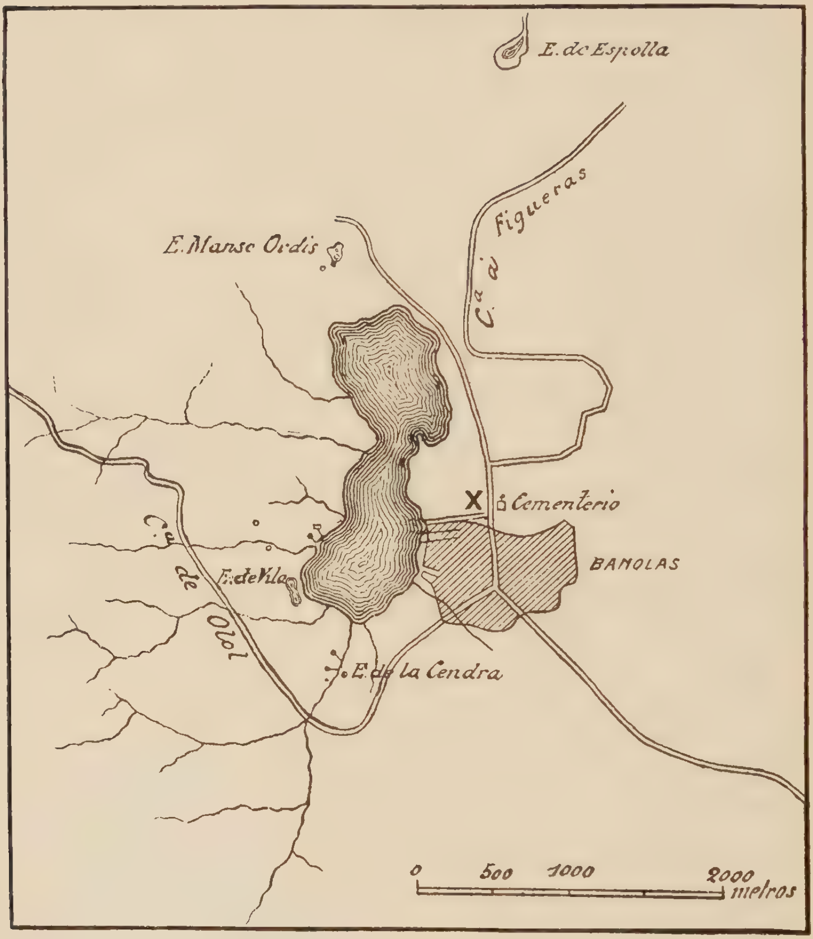
E. de Espolla
Ca. d. Figueras
E. Manso Ordis
X
Cementerio
BAÑOLAS
Ca. de Olot
E. de Vila
E. de la Cendra
0
500
1000
2000
metros

FIG. 34.—Map of Bañolas and vicinity. *X*, site of the jaw. (After Bentabol, Pacheco, and Obermaier.)

Upon carefully chiseling the rock away, Sr. Alsius discovered the human jaw. A portion of the tufa was left adhering to the lingual side of the bone for fear that the latter might crumble to pieces.

The first notice of the discovery was published in 1909 by Professor Manuel Cazurro,[1] who tells us that the specimen lay at the depth of about 5 m. (16½ ft.) from the surface, and that the specimen is nearly complete, lacking only a part of the ramus. The chin is of but slight prominence, the incisors show prognathism, the bone is strong and stout, the muscular insertions very marked, and the third molars are larger than those that precede them; in all of which characteristics the jaw resembles those of La Naulette, Spy, Malarnaud, and other Quaternary mandibles.

In 1912 the specimen is mentioned in a brief communication by E. Harlé.[2] The author tells us that the jaw comes from a very hard travertine that was quarried for building stone, and that was originally deposited by the lake of Bañolas. He calls attention to the receding character of the symphyseal region and to the advanced wear of the teeth.

A detailed description of the specimen was given in 1915 by E. Hernandez-Pacheco and Hugo Obermaier.[3] These authors tell us that the bone is thoroughly fossilized and of the same color as the stone that enclosed it and still fills all the interior of the specimen; it is very fragile; some of the teeth already show cracks due to drying. The left part of the specimen had been damaged during its disengagement. The principal primitive characteristics of the jaw brought out by the authors are as follows:

The transverse diameter of the left condyle, which has left its impression in the tufa, measures 22.9 mm; it permits an estimate for the bicondylar breadth of 11 cm. The neck of the condyle had been very short. The coronoid process, well preserved on the right, is low and obtuse, its height having about equalled that of the condyle. The notch was shallow, as in the mandibles of the Neanderthalers. The rami are relatively low and broad, and nearly vertical. The height of the left ramus from the gonion to the apex of the condyle was approximately 7 cm.; the vertical height from the coronoid process was 6.1 to 6.2 cm.; the minimum breadth of the right ramus is 3.99, or practically 4 cm. The bigonial diameter was about 10.3 cm.; mandibular angle, 105°. The body of the jaw is stout, rather low, and very appreciably convex. The mental foramina are situated beneath the Pm 2. The length of the body, from the posterior border of the ramus to the anterior alveolar point, is 11.08 cm.

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[1] Las cuevas de Serinyá y otras estaciones prehistóricas del N. E. de Cataluña. Annuari del Institut de Studios Cataluns, 1909, Vol. 2, pp. 24-25, 1 fig., Barcelona, 1909.

[2] Harlé, E., Ensayo de una lista de Mamíferos y Aves del Cuaternario, conocidos hasta ahora en la Península Ibérica. Tomo 32 del Boletín del Instituto Geológico de España, pp. 135-162, Madrid, 1912.

[3] La mandibula neandertaloide de Bañolas. Publ. of the Comisión de investigaciones paleontológicas y prehistóricas. Memoria número 6, 42 pp., 9 pls., 2 figs., Madrid, 1915.

Height of the body between second and third molars	2.95 cm.	(R. side)
Height at mental foramen	2.76	(R. side)
Height at symphysis	2.67	

The stoutness of the bone could not be measured on account of the rock which fills the interior of the specimen. The symphyseal region shows but a slight chin eminence. The angle formed by the external line of the symphysis and the basal plane of the body of the jaw measures 85°. The anterior alveolar border and the basal border of the jaw are on a vertical line, in front of which protrudes the slight eminence of the chin. The chin angle is the same as in the La Ferrassie mandible, but is moderately to markedly smaller than in other early jaws.

There is a slight submental arching of the cupid's-bow form; such arching, though generally more pronounced, is characteristic, it has been seen, of the Neanderthal mandibles. The border, anteriorly, is less flat than in most of the Neanderthalers. The dentition is complete and all the teeth, though much worn (especially anteriorly), are preserved. The dental arch is broad anteriorly and parabolic.

The teeth are megadont, sound. The left M3 still shows five tubercles. Correct measurements of the molars are impossible due to the wear; approximations show the third molar to have been at least as large as the second. But the crowns were not of the primitive relatively narrow form, being in fact probably somewhat broader (linguo-labially) than long.

Messrs. Pacheco and Obermaier diagnose the jaw as that of a male of some 40 years of age. They believe that the mandible belongs to Neanderthal man and that, with the skull of Gibraltar, it represents the oldest so far discovered human skeletal remains in Spain.

ADDITIONAL LITERATURE

Bonarelli, Guido. La mandibula humana de Bañolas. Revista de la Sociedad Argentina de Ciencias Naturales, Buenos Aires, Vol. 2, pp. 399-406, 1916.

Sergi, Sergio. La mandibola di Bañolas. Estratto dalla di Antropologia, Vol. 22, 7 pp., Roma, 1917-1918.

RÉSUMÉ OF THE PHYSICAL CHARACTERISTICS OF THE NEANDERTHAL PHASE OF MAN

A perfect knowledge and understanding of the physical characteristics of the Neanderthal man is still far from realization. Science possesses already a very respectable amount of skeletal material from this very important period of human differentiation, but this material is as yet not nearly sufficient. It covers but very fractionally the different parts of the long period; the number of male and especially female adult remains is far from sufficient for the establishment of either the mean types, or their variation; the facial parts are mostly wanting; the brain case is mostly so damaged as to make adequate study of the brain almost impossible; the bones of the trunk and the pelvis are nearly wholly wanting; most of the bones of the hands and the feet are not represented at all as yet, or represented by isolated pieces only, in the collections; and even of the long bones there is not enough for definite comprehensive generalizations. A résumé of the physical characteristics of the Neanderthal man must therefore for the present remain quite imperfect, and to have in many particulars more the value of indications than actual facts. Fortunately the indications in some important respects, at least, are strong and harmonious enough to constitute doubtless close approximations to realities.

A critical study of the differences of the Neanderthal from later and present man brings with it two great appreciations. The one is that the more inferior of these characteristics give us many indications as to the nature of the ancestral stock from which Neanderthal man had developed. Some day it will be quite feasible to reconstruct from our knowledge of the Neanderthal remains the more immediate, at least, of the predecessors of that form.

The other important and growing appreciation is, that in many respects the Neanderthal man did not stand decisively apart, or very far, from later man. In many characters he is seen to interdigitate with the latter; and there is no one of his characters so far discovered in which he does not at least connect with those of later man.

A résumé of the apparent characteristics of Neanderthal man follows:

SKULLCAP

Size—moderate to large.

Form—markedly dolichocephalic—to mesocephalic—to moderate brachycephalic.

Thickness of bones—mostly somewhat to markedly greater than in modern skulls of white man.

Supraorbital ridges—in adults invariably a biarched, complete and more or less stout torus.

Forehead—low and sloping to fairly high and well arched.

Vault—low to moderately high, oval from side to side, without sagittal ridge or keel.

Temporal lines—at a good distance, as a rule, from the sagittal suture.

Parietal eminences—often decidedly lower and more backward than in modern skulls but occasionally approaching conditions in the latter.

Occipital region—relatively broad, somewhat prominent, flattened from above and from below, and with a more or less transverse torus.

Sub-iniac region—often more or less concave above, and less full than in modern skulls.

Temporal squamae—low to moderate.

Mastoids—small.

BASE

Petrous portions stout, on level with surrounding parts and filling anterior lacerated foramen; no styloid or but slight; stout tympanum; marked premastoid groove or space (Hrdlička).

Glenoids—shallow to moderate depth, broad transversely, and other peculiarities.

Basilar portion—relatively flat, condyles rather small; other peculiarities of base.

FACE

Glabella—even with ridges, to a fairly marked depression (from side to side).

Nasal process of frontal bone—stout to very stout and interorbital breadth consequently large.

Large, deep, megaseme orbits.

Orbital plane—upper half inclined more or less forward and downward, due to protrusion of the tori; also a tendency towards increased inclination of plane laterally, outward and backward.

Form of orbits—irregularly circular to irregularly quadrangular. Borders stout; dull to fairly well defined.

Nasal depression—in a broad uniform concavity.

Nasal bridge—of submedium height.

Nasal bones—broad, stout.

Frontal process of maxilla—stout, broad, bulging.

Suborbital (canine) fossae—wanting, region full, perceptibly convex from side to side.

Malars—relatively small, not protruding, sloping backward.

Frontal process—broad and stout; zygomatic process, above modern medium in breadth and strength.

Inferior margin—no masseteric protrusion.

Nose—broad, rather long, aperture approaching simian form; spine submedium to small.

Maxilla—high, stout, and broad.

Upper alveolar arch—high, broad.

Dental arches—broad in front, more or less **U**-shaped.

Facial prognathism—somewhat above that in modern man.

Alveolar prognathism—moderate.

TEETH

Upper incisors—shovel-shaped and with reinforcing lingual cusps.

Canines—modern form.

Anterior premolars—tendency to high outer cusps.

Upper molars—beginnings of obliquity of transverse (linguo-labial) axis.

Lower molars—tendency in most cases towards more or less marked diminution of M3.

LOWER JAW

More or less prognathism of incisors. Receding chin. Flatness of front part due to lateral protrusions caused by stout roots of canines. Beginnings of distinct mental eminence.

Inferior border—tendency to cupid's-bow form, with more or less marked submental ("platysmal") spine.

Mental foramina—often multiple, not seldom duplicate or triple, situated mostly farther back (beneath M1) than in modern skulls. Body stout, seldom high. A marked hiatus between M3 and anterior border of ramus.

Ramus—broad, moderately high, often tendency towards simian rounding of angle.

Coronoid process—broad, mostly low, stout.

Notch—mostly shallow.

Condyle—short, condyle itself broad and mostly stout.

Internal and occasionally also external strengthening crests of both the coronoid process and the condyle.

Lingually, anteriorly, more or less marked shelving; transverse epimedian torus; tendency to simian depression below; small genial tubercles. Transverse torus connects occasionally with mylohyoid ridge. Below mylohyoid ridge in some cases pronounced hollows.

Inferior border, from premolar region forward, broad, flat and with marked impressions of the digastrics.

Internal pterygoid fossae—pronounced and spacious.

Whole bone contrasts from modern by relative stoutness, length of body, conditions both externally and internally of the frontal portion, and large teeth.

No dental decay (caries) observed thus far in any true Neanderthaler (La Chapelle?).

SKELETON

Vertebrae—Spinous processes of lower cervicals tend to project straight backward; bodies—relatively low; indications of various other peculiarities.

Ribs—stout, broader curvatures.

Clavicles—relatively long, slender; other peculiarities.

Scapulae—not well known; occasionally primitive features.

Pelvis and sacrum—not well known; thoroughly human, though evidently some peculiarities.

Long bones—relatively large extremities.

Bones of forearm and leg—relatively short; but little platybrachy, platymery, or platycnemy. Marked arching of radius and of femur. Pronounced muscular impressions.

Popliteal space in femora—tends to be convex.

Linea aspera—slightly to moderately developed.

Head of upper articular facets of tibia tends to more retroversion than in most modern bones.

Olecranon fossa of humerus—larger and deeper than in modern bones. Olecranon process of ulna stouter; peculiarities—particularly shallowness of articular facets.

Bones of hands and feet.—Mostly not well known.

Metacarpus and metatarsus—relatively stout. Tarsal bones stout, squatty; peculiarities of articulation.

Astragalus—stout; short neck; sustentaculum—much developed; other peculiarities.

GENERALIZATIONS

Head.—The head and face were relatively large and heavy; the nose must have been stout, the mouth large, chin receding.

Size of the brain.—In the size of his brain the Neanderthaler compared with man of today; but morphologically the brain was generally inferior.

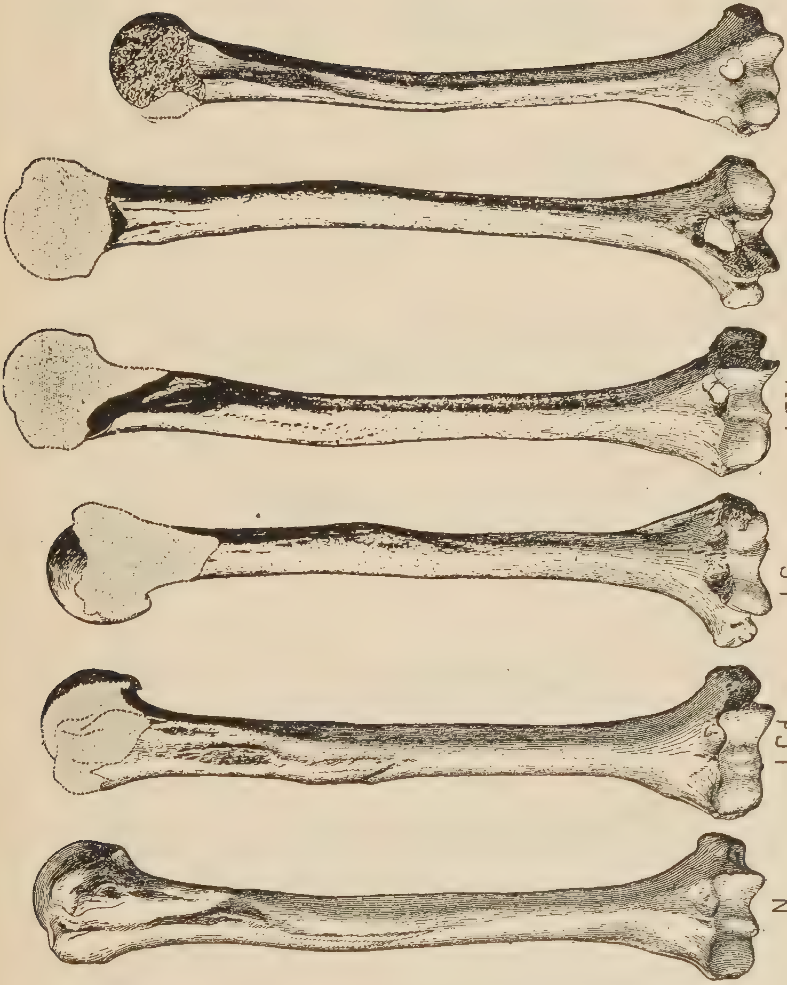
N.
L.C.d.
L.C.g.
L.F.I d.
L.F.I g.
L.F.II

FIG. 35.—Neanderthal humeri: *N* = Neanderthal, *LC* = La Chapelle, *LF* = La Ferrassie. (After Boule.)

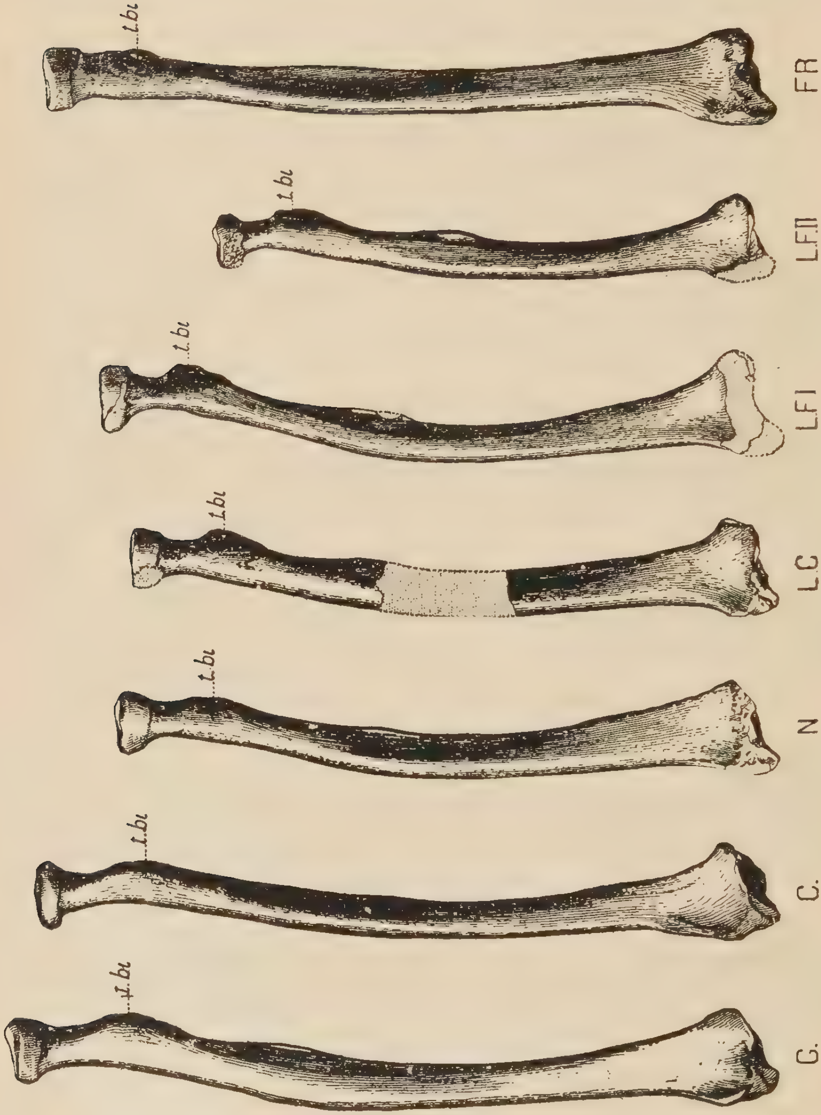
G.
t.bi
C.
t.bi
N
t.bi
LC
t.bi
LFI
t.bi
LFII
t.bi
FR
t.bi

Fig. 36.—Neanderthal radii, compared with those of a gorilla, a chimpanzee, and a modern Frenchman. (After Boule.)

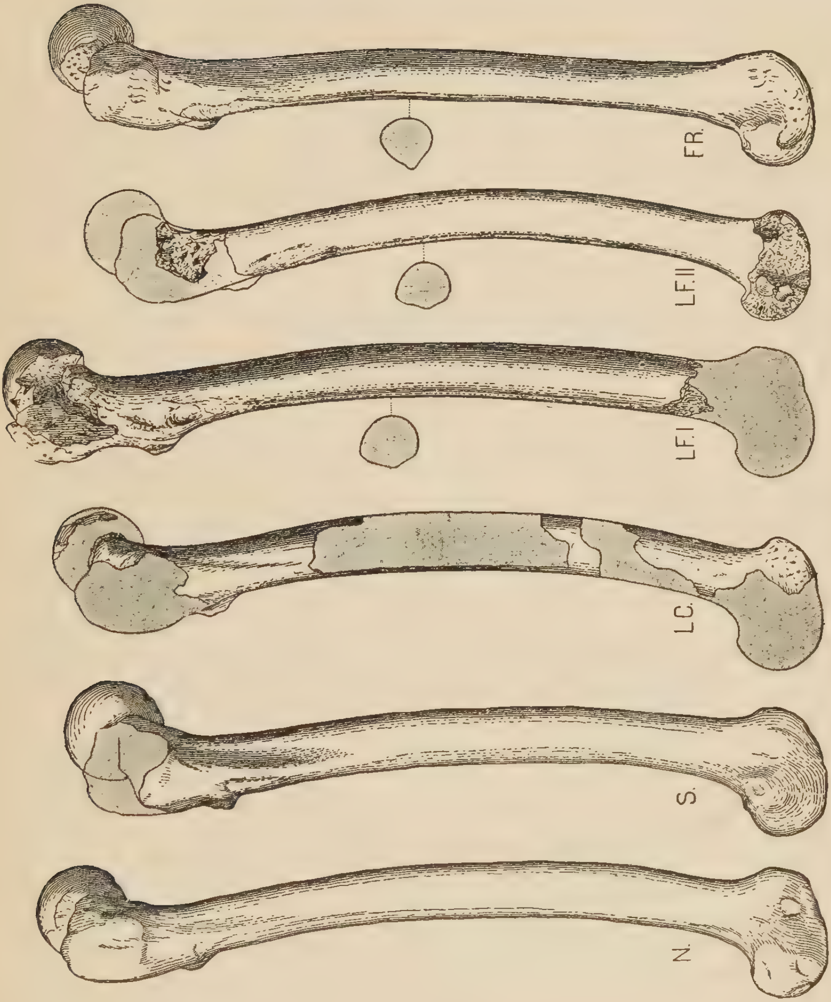
FR.
LF.II
LF.I
LC.
S.
N.

FIG. 37.—Neanderthal femora, compared with that of a modern Frenchman. (After Boule.)

The stature of the Neanderthal man, compared to the modern, was mostly short to submedium, rarely reaching medium.

Proportions.—The Neanderthal man had probably a short but stouter neck and a larger thorax than the man of the present day. He was also, in the males at least, strongly to heavily muscular. His limbs, particularly the lower extremities, were rather short. His hands and feet were broad (rather than long) and strong.

It is doubtful if the Neanderthal man walked as perfectly erect as man of today.

Weight.—Judging from the very stout walls of his long bones and the indicated stoutness of his muscles, the Neanderthal man weighed probably more in relation to stature than man weighs today; but there were also weaker and lighter individuals.

CRITICAL CONSIDERATIONS OF THE NEANDERTHAL PROBLEM[1]

The characteristics and taxonomy of the Neanderthal man have been written about most extensively, but often with but little originality. New finds belonging to his family have become numerous—almost more numerous than legitimate new thoughts. Today it is no more the question of a single or a couple of Neanderthal skulls, as in the time of Darwin, but of a large and important section of man's antiquity, documented ever more geologically, paleontologically, and anthropologically. But the distressing part is that the more there is, the less prehistory seems to know what to do with it. Of speculations there have been indeed enough, but most of them so far have lead not into the sunlight but rather into a dark, blind alley from which there appears no exit.

The generalized present doctrine about Neanderthal man may best be seen from the following brief quotations, taken from five of the most recent and representative authors, two paleontologists, one an anatomist, and two prehistorians:

Marcellin Boule (*Fossil Men,* 1923, pp. 242-43):

> *Homo neanderthalensis* is an archaic species of man. It was abruptly followed by the Aurignacians, "who differed from the Mousterians as much in their superior culture as in the superiority or diversity of their physical characters."

M. C. Burkitt (*Prehistory,* 1921, p. 90):

> The race who made this culture (Mousterian) was of a low type known as the Neanderthal race. This appears to have been a throw back in the line of evolution of mankind, and this retrograde sport seems to have had no successor.

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[1] In the preparation of this section the writer has drawn freely on his The Neanderthal Phase of Man, The Huxley Memorial Lecture for 1927, Journ. Roy. Anthrop. Inst., pp. 249-274, Dec., 1927. Reprinted in Ann. Rep. Smithsonian Inst. for 1928, 1929.

George Grant MacCurdy (*Human Origins,* 1924, vol. 1, pp. 209-10):

> During ages long subsequent to the time when the races of Piltdown and Heidelberg lived, there spread over the greater part of Europe the primitive Neanderthal race, of coarse mental and physical fiber. . . . . This race contributed nothing, in fact, save utilitarian artifacts, the so-called Mousterian industry. . . . . The Aurignacians were a "new race," which supplanted completely the archaic Neanderthal race of Mousterian times.

Sir Arthur Keith (*The Antiquity of Man,* vol. 1, pp. 189-9):

> The most marvellous aspect of the problem raised by the recognition of Neanderthal man as a distinct type is his apparently sudden disappearance. He is replaced, with the dawn of the Aurignacian period, by men of the same type as now occupy Europe. . . . . A more virile form extinguished him. . . . . He was not an ancestor of ours, but a distant cousin.

Henry Fairfield Osborn (*Man of the Cave Period,* in *Man Rises to Parnassus,* p. 79, 1927):

> The Neanderthals present a unique instance of arrested and perhaps partly retrogressive human development.

All these opinions can probably be traced, directly or indirectly, to the authoritative notions arrived at during the earlier years of this century, on material less ample than at present, by one of the foremost students of Neanderthal man, Gustav Schwalbe.

There were, and are, however, also other views. From Huxley and Busk to Karl Pearson; from Fraipont and Lohest, Houzé, Kollmann, and Sergi to Stolyhwo, Gorjanović-Kramberger, and, most recently, Weidenreich, there have been expressed opinions that Neanderthal man was not a different species, and that he did not completely die out, but became gradually transformed into later human forms, from which in turn developed man of today.

B 7 The problem of Neanderthal man, as it now exists, presents the following uncertainties: It is not yet properly known just where, when, and how he began, and how far eventually he extended geographically; it is not yet definitely known just who he was and what were his phylogenetic relations to the man that succeeded him; and it is not known plainly just why and how he ended, and whether or not he left any progeny. Besides which there are still but more or less imperfect ideas regarding the exact length of his period, his average physique, his variations and sub-races, the reasons for his relatively large brain, his changes in evolutionary direction. And there are other uncertainties. It thus appears that, notwithstanding his already numerous collected remains, Neanderthal man is still far from being satisfactorily known to us taxonomically, chronologically, and anthropologically.

This state of uncertainties and of paralyzing premature conclusions concerning one of the main early phases of humanity, is a serious obstacle to further progress, and deserves all possible attention, even if, without further material, it may be possible to do little more than bring into the subject a greater degree of order and comprehensiveness; to point out here and there facts that have not been sufficiently weighed; and to call attention to some of the inconsistencies in the prevalent assumptions.

The presentation will be as far as possible quite neutral; and I wish to acknowledge my deep indebtedness for many of the data to the authors given in the references, as well as to those who in the past, and again during the years just passed, have facilitated for me the study of original Neanderthal sites and materials.

NEANDERTHAL MAN

DEFINITION

The only workable definition of Neanderthal man and period seems, for the time being, to be, *the man and period of the Mousterian culture*. An approach to a somatological definition would be feasible but might for the present be rather prejudicial.

GEOGRAPHICAL EXTENT

The territory already known to have been occupied by Neanderthal man was collectively a very large one, including, roughly, all Europe south of a line drawn from southern England to the northern limits of Belgium and thence, with a moderate curve northward, over Germany and Poland to Crimea and possibly the Caucasus, with parts (at least) of northern Africa and of Asia Minor. Whether he reached farther east, southeast, or south, must, notwithstanding some claims, be regarded as still uncertain.[1]

The whole great territory over which his remains have been discovered was not occupied by Neanderthal man synchronously, or continually, or with equal density. He was evidently not a nomad, though probably still more or less of a rover who stayed in a place for a more or less prolonged time and then moved away. Some of the deposits he left show up to six different layers of reoccupation (Grimaldi, Olha, La Quina, Le Moustier, Krapina, etc.). The density of his remains is greatest in France and Belgium, least in the northern limits of his territory and in the mountainous parts, particularly the

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[1] See Addendum, written after this paper was in type.

Alps, Carpathians, and the Balkan peninsula. The distribution of Neanderthal man in Europe is of much significance, as will be seen later.

LIMITS AND DURATION

The boundaries and duration of the Neanderthal period are those of the Mousterian culture. They may now be delimited with some precision, though not finality, by data of paleontological, geological and archeological nature.

PALEONTOLOGY

Neanderthal man coexisted with a large series of now extinct animals: the question is, how intimately are these forms associated with his coming and going. The Mousterian culture is the culture, essentially, of the earlier times of the mammoth, the woolly rhinoceros, the cave lion, bear, and hyena, the horse, the old ox, the bison, the reindeer, the stag. There are many other forms, but these are the most characteristic.

The Mousterian culture neither comes in, however, nor ends with any of these large mammals. The mammoth, derived probably from the Trogontherium, is present since at least the Acheulian and lasts to, if not beyond, the end of the Magdalenian time. The cave lion, cave bear, and cave hyena, as well as the horse, ox, bison, and even the reindeer are all there since or before the beginning of the Acheulian, and they last throughout the Mousterian, Aurignacian, Solutrean, and Magdalenian periods, to disappear gradually during the latter, or persist to historic times.

Mousterian man begins apparently during the latter part of the last great interglacial and extends deep into the final glacial time, without perceptible direct relation to the fauna. His remains at Montières, Villefranche, Ehringsdorf, the rock-shelter Olha, some of the Mentone caves, and elsewhere, are still associated with the remains of the *Elephas antiquus,* the Merck's rhinoceros, the large lion, and the panther (leopard). On the other hand, various Arctic species (*Ovibos, Gulo, Canis lagopus, Lepus arcticus,* etc.) come in as the cold advances during the Mousterian period, without, however, marking either its beginning or its end. There is, therefore, no definite line of faunal demarcation for either the beginning or the end of the Mousterian period. Neanderthal man did not come in with any special fauna, nor did he go out with any—all of which are facts of importance.

GEOLOGY

Geological information about the Mousterian period is not as precise or full as is desirable,[1] but it permits of several valuable conclusions. A survey of the better-known Mousterian sites, from Germany and Belgium southward, shows that fully one-third of them were in the open, while of the remainder quite a few (La Quina, Sergeac, La Ferrassie, etc.) are found in and about shallow rock-shelters that could not have afforded much protection. In Switzerland, moreover, the earlier Mousterian man lived in caverns at a high elevation (Wildkirchli, 4,905 ft.; Drachenberg, 8,028 ft.).[2] All of this indicates that the climate during a considerable part of the Mousterian period was not severe enough generally to drive man into the caves, or even down from the mountains, thus pointing to interglacial rather than glacial conditions. There is no evidence of any critical geological manifestations, either about the beginning or about the end of the Mousterian period.

The cultural remains of the Mousterian in the open stations, as well as those in caves, denote both considerable age and long duration of the period. In the open the remains lie mostly in old gravels or sand, rarely in clay or loess, or in travertine rock of lacustrine origin. There may be two or three cultural strata or horizons (as at Ste. Walburge, High Lodge, Ipswich, Amiens, etc.), indicating a repeated occupation of the same site after shorter or longer intervals, though there have not been found as many occupational layers as in some of the caves.

ARCHEOLOGY

Neither paleontology nor geology, evidently, explains Neanderthal man; perhaps we may learn more from archeology.

OCCUPATIONS

The chief activities of man in nature relate to his housing and clothing, to the obtaining and preparing of his food, and to the manufacture of tools, utensils, and weapons. Let us see briefly how Neanderthal man compared in these respects with his forbears and his followers.

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[1] Many details are given in Bayer, Jos. Der Mensch im Eiszeitalter, Leipzig and Wien, 1927; in Werth, E., Der fossile Mensch, 3 parts, Berlin, 1921-1928; and in the books of Boule, Keith, MacCurdy, Obermaier, Sollas and others on prehistory cited at the end of this treatise.

[2] See MacCurdy, G. G., Human Origins, Vol. 1, 1924.

Housing.—There is a prevalent idea that Neanderthal man was essentially a cave-dweller, and this idea seems generally to carry with it a sense of inferiority. The records now available throw a different light on this matter. Analysis of 360 better-known paleolithic sites in Europe and the neighboring regions (from records compiled principally by MacCurdy)[1] gives the following interesting information:

DWELLINGS IN THE OPEN AND IN CAVES DURING PALEOLITHIC TIMES

Period	Sites in the Open		Rock-Shelter or Cave	
	Number recorded	Per cent.	Number recorded	Per cent.
Pre-Chellean	11	*100*	..	..
Chellean	32	*94*	2	*6*
Acheulian	36	*78*	10	*22*
Mousterian	45	*34*	88	*66*
Aurignacian	24	*18*	112	*82*
Solutrean	10	*14*	62	*86*
Magdalenian	17	*10*	148	*90*
Azilian and Tardenoisian	4	*9.5*	38	*90.5*
Accompanying Neolithic	22	*22.5*	76	*77.5*

The figures and chart (fig. 38) show some curious and important facts. Man begins as a dweller in the open, but already since the warm Chellean period he commences also to utilize rock-shelters and caverns, and then, as the climate cools, he gradually takes more and more to the caves. In these phenomena the Mousterian period shows nothing striking, nothing individual. It falls harmoniously into the curve of the progress of cave-dwelling, to be followed equally harmoniously by the Aurignacian and the succeeding periods. Mousterian man occasions no perceptible disturbance in the human housing conditions of the time, and what is even more remarkable, no disturbance or change whatsoever is found to be occasioned by the advent of the Aurignacian. Aurignacian man follows in the footsteps of his predecessor without a marked interruption. Like the Neanderthaler, he builds, in the open, huts of perishable materials that leave no trace, and he utilizes the caves exactly as much as, and eventually even more than the Neanderthal man. He continues, in fact, on many of the same sites and in most of the same caves that the latter has used, without introducing any detectable innovation. He, also, like the Neanderthal man, leaves here and there a whole series of occupational

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[1] Human Origins, Vols. 1 and 2, 1924.

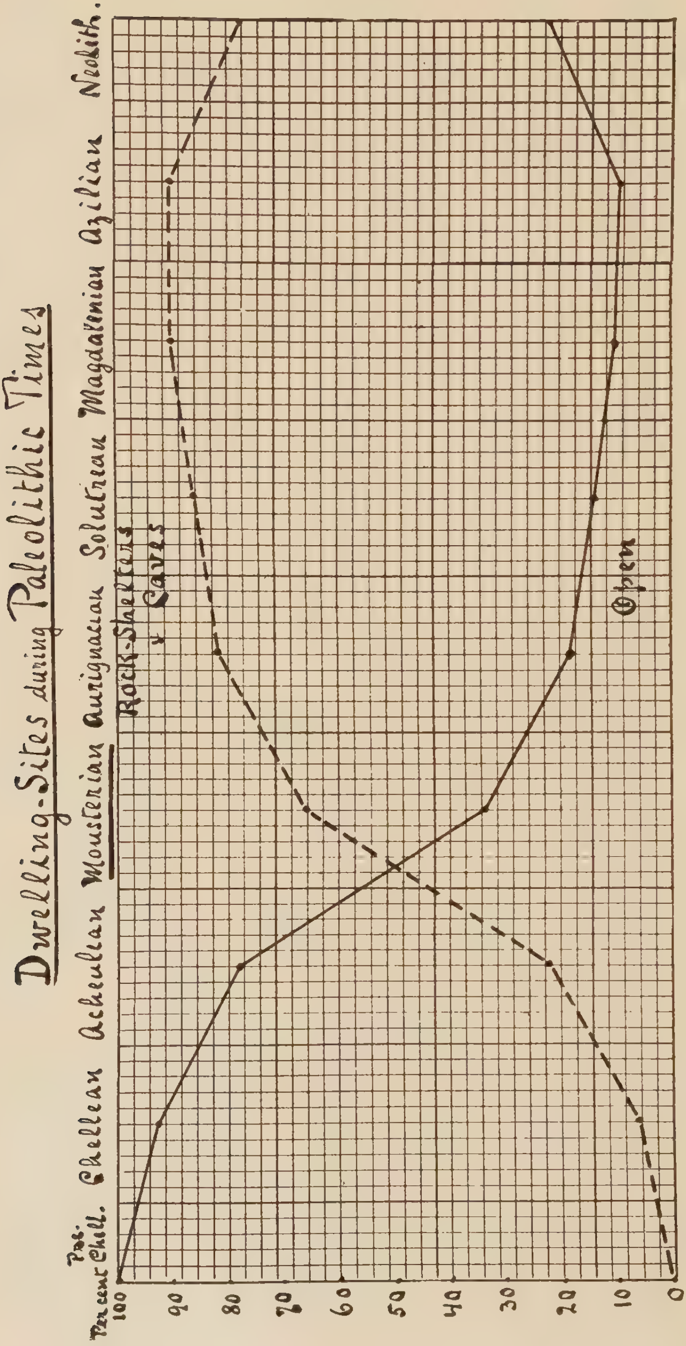
Dwelling-Sites during Paleolithic Times
Percent
Pre-Chell.
Chellean
Acheulian
Mousterian
Aurignacian
Solutrean
Magdalenian
Azilian
Neolith.
Rock-Shelters + Caves
Open
100
90
80
70
60
50
40
30
20
10
0

FIG. 38.

strata which testify to much the same habits of life. Yet Aurignacian man is often represented as a new-comer, of a different species from that of the Neanderthaler, and mentally vastly superior.

Clothing.—About the clothing of Neanderthal man nothing is known directly, as is also the case with Acheulian and Aurignacian man. But the cooling climate, on the one hand, with the much increased numbers of tools with a cutting-edge and especially of scrapers that occur in the Mousterian and later deposits, on the other hand, indicate extensive preparation of the skins of animals, to be used, doubtless for clothing and bedding. No sudden change in this connection is observable from the Acheulian to the Mousterian or from the Mousterian to the Aurignacian period.

Food.—Neanderthal man was chiefly a hunter and trapper of the larger mammals of his time. He knew fire, but knew not domestication of animals, or agriculture. He compared in these respects with the preceding and following man as follows:

FOOD, AND HABITS RELATING THERETO

Acheulian man	Mousterian man	Aurignacian man
Chiefly a hunter and trapper.	Chiefly a hunter and probably trapper.	Chiefly a hunter and trapper.
Fisher (?).	Fisher (probably).	Fisher.
Use of molluscs—no trace yet.	Use of molluscs (?).	Use of molluscs.
Knew fire.	Knew fire.	Knew fire.
Preparation of food: probably by roasting on fire or coals—no trace of any vessels for boiling.	Preparation of food: probably by roasting on fire or coals—no trace of any vessels for boiling.	Preparation of food: probably by roasting on fire or coals—no trace of any vessels for boiling.
No agriculture.	No agriculture.	No agriculture.
No domestication of animals.	No domestication of animals (?).	No domestication of animals (?).
Bones broken for brains and marrow.	Bones broken for brains and marrow.	Bones broken for brains and marrow.
Bones and refuse accumulations in inhabited caves, and in front of them.	Bones and refuse accumulations in inhabited caves and in front of them.	Bones and refuse accumulations in inhabited caves and in front of them.
No trace of storage of food.	No trace of storage of food.	No trace of storage of food.
Pictorial representation of hunted animals—not known.	Pictorial representation of hunted animals—none known yet positively.	Pictorial representation of hunted animals—gradual development from crude beginnings.

Evidently, in food and food habits, as in housing, Mousterian man was quite like both the Acheulian man that preceded him, and the *Homo sapiens* that followed.

Tools.—The bulk of the Mousterian period is characterized by a definite phase of stone industry, but so are all the periods before and after it. It has no sudden beginning. It uses flint where this can be had, as do all the other industries; where flint is absent or scarce, it employs quartzite and other stones. The use of bone begins in the Mousterian, to increase henceforward. The period shows three stages of cultural evolution, the lower, middle, and upper, as do also later the Aurignacian and the Magdalenian periods. The implements range from crude to beautifully made (as at La Ferrassie, La Quina, Le Moustier, Jersey, Sergeac); the technique is partly different from, but in general not inferior to, either the late Acheulian or the earlier Aurignacian; and there are indications that there was no general sudden ending of the culture.

On the whole the Mousterian industry, though characteristic, does not provide evidence of anything wholly new and strange, intercalated between the Acheulian and the Aurignacian, beginning abruptly by displacing the former or ending suddenly through displacement by the latter. There is much in fact at either end that appears to be, more or less, of a transitional nature.

Thus, even in H. F. Osborn's opinion (Obermaier, 1924, p. x), the Mousterian "constitutes a further evolution of the two earlier cultures"—the Chellean and the Acheulian. At Ehringsdorf, in the lower travertine, "the technique of the chipping is Acheulian, but the forms are largely Mousterian" (MacCurdy, *Human Origins,* 1924, vol. 2, p. 392). According to Burkitt (*Prehistory,* 1921, p. 27), " . . . . workers in Dordogne find a great difficulty in distinguishing between Upper Acheulian beds and Lower Mousterian beds. In fact, M. Peyrony often only solves the problem by the absence or presence of reindeer." And quotations of similar import could be multiplied. As to the upper limits—at the Cotte de Ste. Brelade, Jersey, excavated by Nicolle, Sinel, and Marett, the upper (fifth) layer gave graceful implements "that may be either upper Mousterian or Aurignacian" (Burkitt). At Le Moustier, the type-station of the Mousterian industry, the upper rock-shelter showed eight layers, "the top one being Aurignacian, the second transitional (Audi), and the rest Mousterian, except the seventh which was sterile." The lower rock-shelter was even more instructive. The section from top to base was: 6. Lower Aurignacian; 5. Transitional (Audi); 4. Typical Mousterian; 3. Mousterian with Audi forms and few *coups-de-poing;* 2. Mousterian with some Audi forms and many *coups-de-poing;* 1. Some Audi forms, no *coups-de-poing* (Burkitt, 1921, p. 93). But perhaps the best comprehensive statement on this subject is that of MacCurdy, one of the oldest and most cautious students of prehistory. In his *Human Origins,* 1924, vol. 1, pp. 161-2, we read: "In certain French stations, a transition from the Mousterian to the Lower Aurignacian occurs, as for example, at Le Moustier (Dordogne), La Verrière (Gironde), and especially at the rock-shelter of Audi in the village of Les Eyzies. In comparison with Mousterian points, those of Audi are more slender and are slightly recurved. The convex margin is rendered blunt by retouching so as not to injure the hand while using the opposite margin for cutting or other purposes. Such a tool, as much a knife, or scraper, as a point, bridges the gap between the Mousterian point or double scraper and the Lower Aurignacian blades of the Châtelperron type. At Audi it is associated with small cleavers and disks, scrapers, spoke-shaves, asymmetric points, and scratchers. The Grotte des Fées at Châtelperron, though distinctly Aurignacian, is so closely related to the transition stage that the chronologic difference must be small. An intermediate stage is recognizable at La Ferrassie (Dordogne)."

The Audi culture is still somewhat controversial, Abbé Breuil (recent letter to the writer) regarding it as "degenerate Mousterian." Notwithstanding this, the impression is growing that the more the initial and the terminal stages of the Mousterian industry are becoming known, together with the late Acheulian and the earliest Aurignacian, the less abrupt and striking appear their differences and the greater grows the feeling that they are not absolutely separated. Some interesting things in this connection have been encountered at Spy as well as at Krapina, and others are now being gathered by Absolon in Moravia.

SEQUENCE OF CULTURE

The sponsors of the view that Aurignacian man was a man of different and superior species to the man of the Mousterian period, conceive him generally as an invader who came from somewhere outside the Neanderthal area, overwhelmed the established less capable species, brought about its rapid annihilation, and replaced it wholly, over all the great domain over which it once extended. These ideas, however, are never expressed very clearly, and little thought is given to the incongruities they involve.

They would imply, first of all, the invasion of Europe during the height of the last glaciation. This is not in harmony with the main laws of human and biological spread, namely: Movement in the direction of least resistance, and movement in the direction of better material prospects, which latter are, first of all, climate and food. In the entire history of Europe, free movements of men have tended always toward " a place in the sun " and away from the cold.

Such views postulate, next, relatively large numbers of the newcomers to suffice for the vast task. But such large numbers would necessarily mean somewhere near a still larger mother-population, and there is no trace, either in western Asia or northern Africa, the only regions from which such invasions at those times would have been practicable, of any such great Aurignacian population. Moreover even in those parts everywhere the Aurignacian follows upon the Mousterian.

It is a very serious question whether in paleolithic times, when man was without tamed animals, without stocks of non-perishable food, dependent wholly on hunting without yet a bow and arrow, and in the imperfect social organization of that time, any larger armed invasion would have been feasible. A peaceful extension, on the other hand, would not lead to the annihilation or expulsion of the invaded population, but to a greater or lesser amalgamation with the native stock. A complete displacement of an extensive group by any agency is difficult to conceive, and there would remain to be explained the fate of the displaced people.

It stands to reason that these great difficulties would have to be satisfactorily explained away before there could be a general intelligent acceptance of an Aurignacian invasion with Mousterian extinction.

Finally, the coming of a distinct and superior species of people ought to have left a very tangible record on the sequence and nature of the cultural levels of the two stocks.

As to sequence, 257 of the better-known and recorded Mousterian sites (as recorded by MacCurdy) show, on analysis, the conditions given in the table on page 337.

The Mousterian culture, in nearly one-half of its stations in the open, follows, it is seen, direct upon the Acheulian; and the Aurignacian, in very nearly one-half of the rock-shelters and caves, and in not far from one-third of the stations in the open, follows upon the Mousterian. It would seem that these figures speak for a rather close relation of these peoples in their habits, and that particularly between the Mousterians and Aurignacians—who should represent two different species of man, one greatly superior to the other.

An objection may here be raised to the effect that the number of available, and especially of the more suitable, caves was limited and, therefore, the same caves that once served the Neanderthalers had to be used also by the shelter-needing Aurignacians; but this point is invalidated by the showing of the Solutreans and Magdalenians, who were even more cave-dwellers than the Aurignacians, yet are found collectively in less than one-fourth of the Mousterian caves. Another point is, that it is not always the lower or earliest Aurignacian that follows upon the Mousterian. But such a discord is common to all the periods. It may mean a discontinuity, and may also mean a persistence of any given culture in some localities longer than in others. In both cases, however, it would speak against a sudden general displacement of one culture.

SEQUENCE OF INDUSTRIES

——	Open Stations		Rock-Shelters and Caves	
Mousterian Topped by:	No.	Per cent	No.	Per cent
(No culture)	(34)	(55.7)	(15)	(18.9)
Neolithic	4	6.6	4	5.1
Magdalenian	3	4.9	9	11.4
Solutrean	2	3.3	10	12.7
"Paleolithic"	1	1.6	2	2.5
Aurignacian	17	27.9	39	49.4
	(61)	....	(79)	....
Mousterian				
	(54)	....	(63)	....
Mousterian Reposing on:				
Acheulian	24	44.4	4	6.3
Chellean	5	9.3	3	4.8
(No culture)	(25)	(46.3)	(56)	(88.9)

There is evidently much here, once more, to be explained by those who conceive of Aurignacian man as very distinct from, and superior to, the Mousterian, and as having suddenly replaced the latter.

ART

The Aurignacian period does not appear to come in full-fledged, as is sometimes taken for granted, but to develop locally, both in industry and art, from humbler beginnings (Breuil, Burkitt, Evans, MacCurdy, *et al.*). Also there seems to be more difference in these respects between the lower and the middle Aurignacian than there is between the lower Aurignacian and the upper Mousterian with the Audi and the Châtelperron stages.

It may, moreover, be unjust to assume that Mousterian man was devoid of art-sense. He may not have left any designs in caves (though that is not perhaps certain), but the same is true of the bulk of the Neolithic and many other early, as well as later, populations. How many such designs, or other permanent forms of art, for instance, have been left by the post-Neanderthal man of England, or Belgium, or Germany, Moravia, Poland, or Russia? How many have been left more recently by such highly artistic people as the Slovaks and the peoples of the Carpathians and the Balkans? And how many cave designs comparable to those of southern France and northern Spain do we find in the whole continent of America, with all its able and highly artistic population, a large part of which—the Lagoa Santa-Algonkin type—may even be blood-related to the late Aurignacians? On the other hand, practically a replica of the European cave-art was produced by the lowly Bushmen of South Africa, who certainly were no superior race or species.

That the Mousterians may not have been lacking in artistic sense is indicated by some of their beautiful implements from La Quina and other stations; by the beautiful topaz and then by a crystal cleaver found in 1925-6 by the American school at Sergeac; by the decorated bone fragment from La Ferrassie; and possibly by the *pierres-figures* (*e. g.,* Roellecourt, Dharvent), and used chunks of manganese oxide, found occasionally in the Mousterian deposits (*e. g.,* La Quina, Henri Martin). Sir Arthur Evans tells us that, " When we turn to the most striking features of this whole cultural phase, the primeval arts of sculpture, engraving, and painting, we see a gradual upgrowth and unbroken tradition. From mere outline-figures and simple two-legged profiles of animals we are led on step by step to the full freedom of the Magdalenian artists " (" New Archaeological Lights on the Origins of Civilization in Europe," by Sir Arthur Evans, *Science,* 1916, n. s. Vol. 44, No. 1134, p. 406). MacCurdy is even more direct: " The inception, development, and decay of Quaternary art all took place during the upper paleolithic period. The beginnings of sculpture, engraving and fresco are traceable to the Aurignacian epoch " (MacCurdy, *Human Origins,* Vol. 1, p. 155). And there are some very good words of appreciation of the abilities of Mousterian man in Sir Arthur Keith's recent two volumes (*The Antiquity of Man,* 1925, Vol. 1, p. 223).[1] Thus archeology fails also, as did paleontology and geology, in isolating Neanderthal man, and in separating him from the succeeding forms of humanity.

THE SKELETAL REMAINS

The crucial part of the whole question of Neanderthal man is, however, that of the evidence of the skeletal material, for it is essentially upon this that the separateness and discontinuance of the Neanderthal type of man has been based. It would probably be easy to harmonize all the rest of the differences between Neanderthal and later man with the idea of a simple evolution and transmission, were it not for the obstacle of the Neanderthal man's skulls and bones. These impress one by such marked differences from those of any later man, that a bridging over of the gap has, to many, seemed impossible.

It will be well in this connection to contrast the Neanderthal remains with those from the Acheulian on one side, and those from the Aurignacian and the following periods on the other. The results are unexpected. There is nothing authentic from Acheulian times; and there is less, in the number of finds, from the Aurignacian than there is from the Mousterian period. Moreover, what there is from the Aurignacian is found, on consulting the details of the discoveries, to be essentially middle and upper, rather than the most needed early Aurignacian. The data leave a strong impression that the material, and especially that from the earlier portion of the Aurignacian period, is still far from sufficient for drawing from it any far-reaching deductions.

Taking the Neanderthal remains by themselves, we find that, notwithstanding their defects, they constitute a very respectable array of precious material. Let us see what it teaches. If we placed all this material on a table before us, ranged by the date of discovery, we should see a remarkable assembly of more or less deficient or fragmentary skulls, jaws, and bones, with a good number of loose teeth, the specimens differing widely in color, weight, state of petrifaction, and in principal morphological characters. We should be struck by the prevailing aspect of age and somatological inferiority of the material, but the arrangement would soon prove unsatisfactory and we should proceed to another. As there is not enough for a geographical subdivision, it would be logical to try next an arrangement of the specimens by their antiquity, from the oldest to the latest. The indications are that the Mousterian period was a long one, and of three cultural stages—the inferior, middle, and superior. We should like, therefore, at least to arrange our material by these stages.

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[1] "In size of brain Neanderthal man was not a low form. His skill as a flint-artisan shows that his abilities were not of a low order. He had fire at his command, he buried his dead, he had a distinctive and highly evolved form of culture—Neanderthal man was certainly not a dawn form of humanity."

But we strike at once great difficulties. The very type-specimen of the lot, the Neanderthal skeleton, lacks direct chronological identification. There were neither animal nor industrial remains with it, or, if there were, they were not saved. Everything indicates that it is very old: physically it is in every one of its parts a prototype of Mousterian man; chronologically it may be even pre-Mousterian. Similar and other difficulties confront us in the case of the first Gibraltar skull and the Bañolas jaw, the important Krapina remains, and the Ehringsdorf jaws; and it is not certain just where within the period to place most of the remaining specimens. The final conclusion is that, if the eyes are shut to the somatological characters of the remains, a satisfactory chronological grading of them becomes very difficult and uncertain.

The state of preservation or petrifaction of the remains is a question of local geophysics and geochemistry, and therefore incapable of giving any fair basis for classification. Thus there remain only the somatological characteristics of the skulls and bones themselves, and the endeavor to arrange them on this basis proves of much interest.

The general physical characters of the Neanderthal race have been more or less summed up by a number of eminent anatomists and anthropologists, including especially Schwalbe, Boule, Keith, and Sollas. The main features of the average Neanderthaler are therefore fairly well known. They include a moderate stature, heavy build, and a good-sized, rather thick, oblong skull, with pronounced supraorbital torus, low forehead, low vault, protruding occiput, large, full upper maxilla, large nose, large teeth and a large, more or less heavy lower jaw with receding chin. To which may be added stout bones of the skeleton, particularly the ribs and the bones of the lower part of the body, femora and tibiae with heavy articular extremities, the tibia relatively short and with head more than now inclined backward, a peculiar astragalus, and a variety of secondary primitive features. To this generalized type some of the specimens conform, it is soon seen, much more than others. It is realized that the general conception of the type has been built up essentially on the Neanderthal, Spy No. 1, the La Chapelle and the adult La Quina skulls and skeletons, but that from this generalization there are many aberrations.

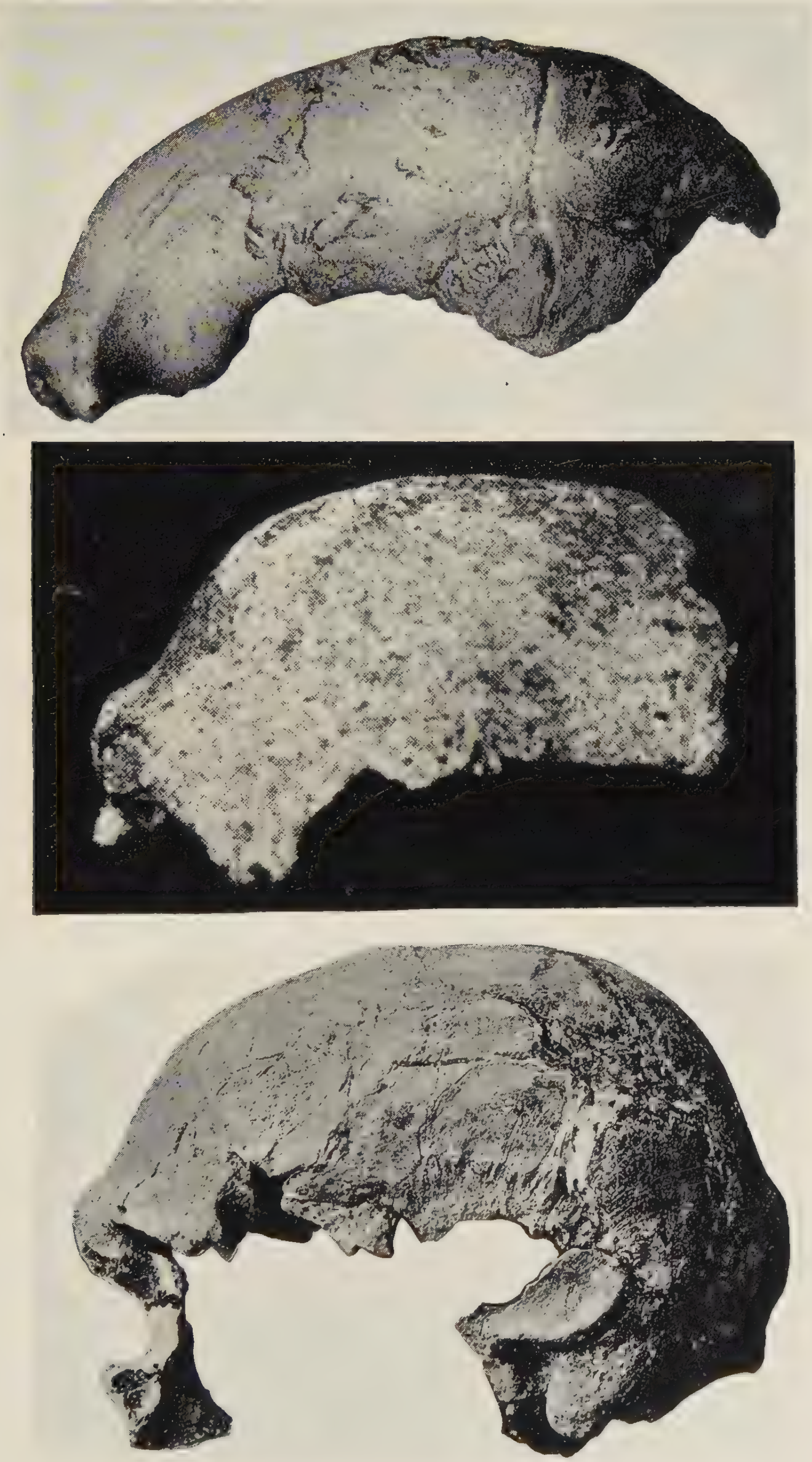
An arrangement of the specimens in morphological order, beginning with those that show the most primitive or old features and advancing gradually towards more modern standards, is now in order, and the results are very striking. The first strong impression is that, with all the seeming riches, there is still not nearly enough material for satisfactory grading. The next appreciation is that it is hard to grade whole lots, but that it is necessary to grade the skulls, jaws, teeth, and bones separately. In one and the same skeleton are found parts and features that are very primitive and far away from man's later types, with parts and features that are practically modern; and every skeleton is found to differ in these respects. Here is facing us, evidently, a very noteworthy example of morphological instability, instability, plainly, of evolutionary nature, leading from old forms to more modern.

The Neanderthal skull and skeleton proper, in all the parts that have been saved, is found to stand at the base of the series. It lacks, regrettably, the lower jaw and the teeth, as well as the sternum, most of the scapulae, and the ribs, vertebrae, sacrum, the leg, the hand and the foot bones. Of what is present, the farthest from modern type is the skull, the next being the thigh bones; the nearest to modern forms, though still somewhat distinct, are the bones of the upper extremity. The closest in general to the Neanderthal skeleton is Spy No. 1, La Chapelle, and apparently the Le Moustier youth. But Spy No. 1 has almost primitive-modern jaws with practically modern teeth; the La Chapelle shows high cranial capacity, an " ultra-human " nose, and a strongly developed nasal spine; the Le Moustier skull has a higher vault and forehead, with less protrusion of the occiput; while the bones of the upper extremity in all three approach closely to the modern types. Thus, even in these most nearly related four specimens, there is in evidence a considerable variability, with more or less advance in various parts in the direction of later man.

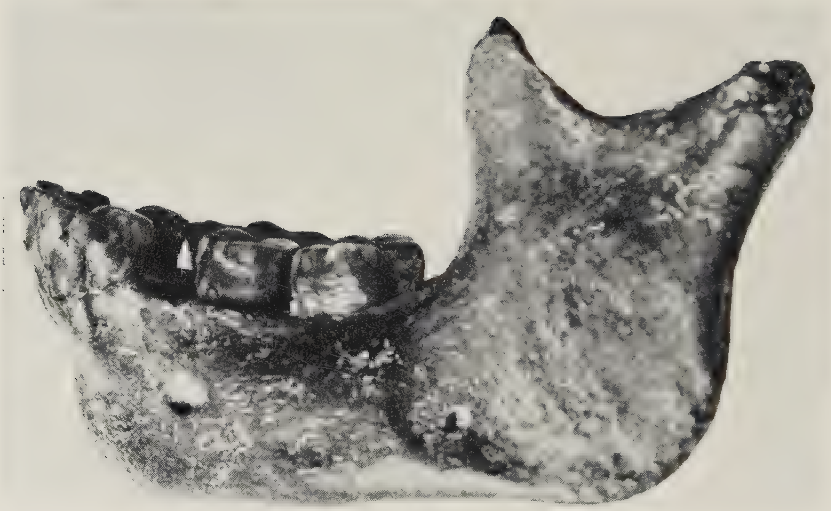
These facts deserve, undoubtedly, earnest consideration. But there is much more to be learned. Taking the remainder of the skulls, jaws, and bones attributed to the Neanderthal man, it is seen that both the variability and the number of characters that tend in the direction of later man increase considerably. The Krapina series, by itself, is probably more variable from the evolutionary point of view than would be any similar series from one locality at the present. This is true in respect to the cranial form, the development of the forehead, the jaws, the teeth, and that of some of the bones of the skeleton. The additional Neanderthal remains manifest signs of similar instability of type and of tendencies of an evolutionary nature, this being particularly true of Spy No. 2, and of the recently discovered Galilee and Ehringsdorf crania. In his excellent description of the Galilee specimen, Sir Arthur Keith has shown that it has a fair forehead with " no suggestion in the vaulting of its frontal bone that the roof of the skull was low and flat, as is usual in Neanderthal skulls." And in his fine reports on the Ehringsdorf (1925, 1927) cranium, F. Weidenreich shows us a specimen with even better developed frontal region, and a vault of good height.

But the most instructive, though most neglected, specimens in this connection are the crania of Spy, Belgium. Here the student is confronted with a find in the same terrace and deposits, at the same level, and but 6 feet apart, of two adult male skeletons from the later Mousterian time. One of these skeletons, No. 1, has a skull the vault of which is like a replica of that of the Neanderthal cranium, with typically Neanderthal bones of the skeleton. But this same skull is associated with upper and lower jaw and teeth that may be duplicated today among the lower races. And the skull of the second skeleton is so superior in size, shape, height of the vault, and height of the forehead, to No. 1, that the morphological distance between the two is materially greater than that between No. 2 and some of the Aurignacian crania, such as the Most (Brüx) or Brno No. 1 (Brünn) specimens.

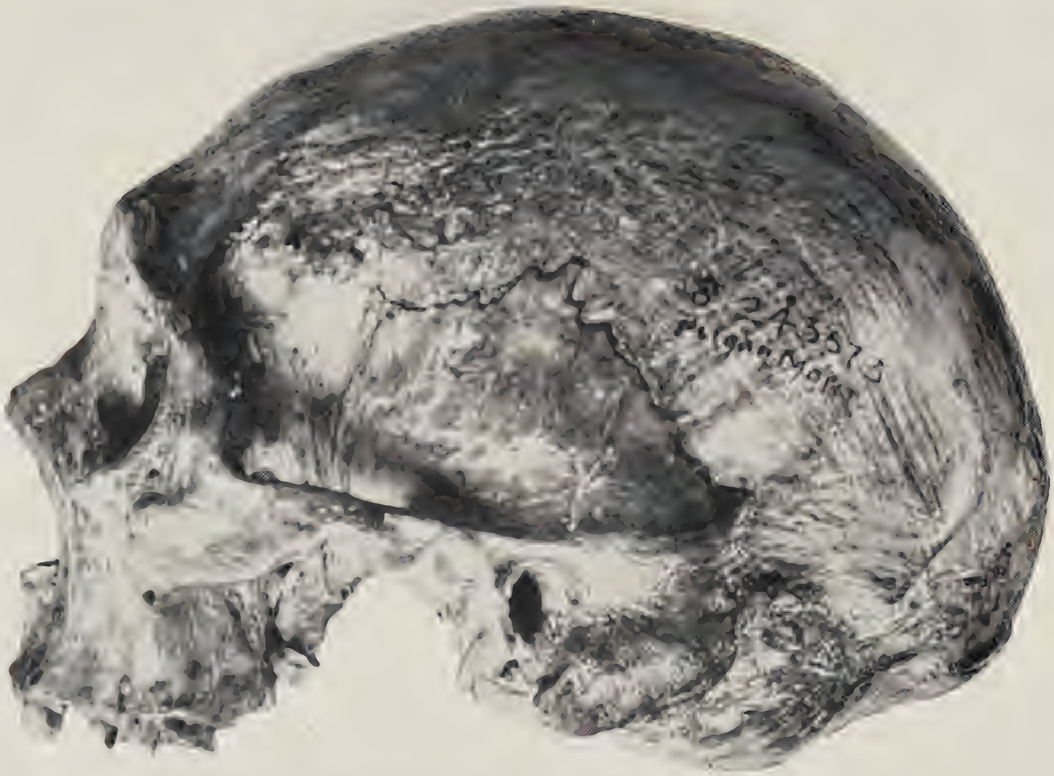
About the most distinguishing and important marks of difference of the typical Neanderthaler from later man are, we may repeat, the lowness of his head, with low receding forehead and a peculiar protruding occiput; a heavy, supraorbital torus; a heavy, chinless jaw; and, as determined from intracranial casts, a low type of brain. It will be well to see how these characters stand the light of our present knowledge. Lowness of the vault, low and receding forehead, and projecting occiput, all show in the series of the Neanderthal skulls known today a large range of gradation, the lower limits of which are well below, but the upper grades of which are well within, the range of variation of the same characters in later, and even present, man. There exists today a whole great strain of humanity, extending from Mongolia deep into America, which is characterized by low vault of the skull (see *Cat. Crania, U. S. Nat. Mus.*, Nos. 1 and 2; also *Bull.* 33, *Bur. Amer. Ethnol.*). Low foreheads are frequent in prehistoric America (*Bull.* 33, *Bur. Amer. Ethnol.*, and *Proc. U. S. Nat. Mus.*, Vol. 35, pp. 171-75, 1908). The pronounced Neanderthal occiput, such as shown by the La Chapelle, La Quina and La Ferrassie



Skulls of Most (Brüx), upper; Podkoumok, middle; and Brno (Brünn) No. 1, lower: showing transitional features. (Hrdlička.)



Transitional form: Lower jaw of an Australian woman. (Skull No. 331,347. U. S. National Museum.)



A Piegan Indian skull (recent), showing a neanderthaloid type (Hrdlička) (Specimen No. 243,673, U. S. National Museum.)

skulls, would be difficult to fully match in later man; but on the one hand the character is not present or marked in all the Neanderthalers, while on the other there are decided approximations to it among recent skulls.

A heavy supraorbital torus, such as is common to the Neanderthal skulls, is not found in later man; but not all the Neanderthalers had the torus equally developed (*e. g.*, Gibraltar), and, as has been pointed out by Huxley, Sergi, Stolyhwo, the author and others there are later male skulls in which there is a marked approach to the torus. A whole series of specimens may be mentioned (Podkoumok, Brüx, Brno No. 1, Předmost, Obercassel, Alcolea, Djebel-Fartas, two neolithic skulls at Warsaw, the neolithic miner from Strépy at Brussels, etc.) in which the feature is of a distinctly transitional character. Moreover, it is well known that, first, the torus is essentially a sexual (male) and adult feature; second, that a reduction of such characters is easier than that of those which are more deeply rooted; and third, that in the civilized man of today a continuance of such reduction is still perceptible. There is less difference in this respect between the Neanderthal and the skulls just mentioned than there is between these and the mean development of the ridges in the highly cultured man—or, for that matter, the ordinary African negro—of the present.

Heavy, large, and receding lower jaws, such as the La Chapelle and some of the Krapina specimens, are among the most striking characters of Neanderthal man. Jaws such as these are not known in later skulls. But with them we have within the Neanderthal group itself specimens very much more advanced morphologically toward the present human type, such as Spy No. 1, La Quina (1912), and the La Ferrassie. Even at Krapina itself some of the jaws are of a less primitive type than others. Let us add to this the various huge, nearly chinless, and even receding jaws that occur now and then in the Australian, Melanesian, Mongolian, American Eskimo, and Indian, and the picture loses much of its discontinuity. Much the same may be said also of the teeth. Teeth of primitive form—incisors, canines (*dents du chien*), molars—occur to this day (see *Am. J. Phys. Anthrop.*, 1922-24), while practically modern teeth may already be observed in Spy No. 1, and more or less also in other jaws of the Neanderthal group.

As to the bones of the skeleton, the conditions are quite as significant as those of the jaws and teeth. There are scales of gradation from forms that stand considerably apart from those of later man (as in Neanderthal, Spy, La Chapelle, Le Moustier) to forms that approach to, or merge with, the modern (many parts of the Krapina, La Ferrassie, La Quina skeletons). To which may be added a word about the brain.

The size and variation of the Neanderthal brain are comparable with those of the Aurignacian, and even the present primitive man. The idea that the Aurignacians were exceptional in this respect is, if due regard be given to the factor of stature, erroneous. The surface conformation of the brain, as shown by intracranial casts, is of a low type in the Gibraltar, La Chapelle, and other specimens. But this does not hold true of the Weimar or the Galilee brain. The intracranial cast of the Galilee skull shows, in the words of Sir Arthur Keith, that "in its mass and its markings it has reached at least to the level attained by individuals in living races—such as that represented today by the aborigines of Australia" (*Report on the Galilee Skull,* p. 106). And the brain of Spy No. 2, as well as that of the Gibraltar child, were both large and well formed.

RECAPITULATION

In relation to what perhaps was its most important period, the Mousterian, prehistory is found to have reached a position approaching dogmatism. But this has only led into a blind alley, from which so far there has been found no exit, notwithstanding much speculation. It has been decided, on the weight of a limited initial group of specimens, that Neanderthal man was a man of a different species; that he may possibly have originated from his European predecessors, but that, after a long period of existence and after having spread far and wide, he perished abruptly and completely, without leaving any progeny, on the approach of a superior species, the *Homo sapiens.*

This *H. sapiens* has been assumed to have come from elsewhere, possibly from Africa or Asia; he was, somehow, cryptically, coeval from far back with the pre-Neanderthaler and the Neanderthaler, eventually to assert himself suddenly and completely, to take over the human burden. He comes on the stage in body and brain largely as man is today, and has, since the beginning of the Aurignacian, undergone but slight alteration.

A whole line of the foremost workers in prehistory are seen to have become identified with these notions, which obliges every student to give them earnest and respectful attention. But no notion or dogma can possibly reach the status of a fact before it has been proven to be such through full demonstration. Owing to scarcity of material, such demonstration has hitherto in this case been impossible; but the more the material remains of early man accumulate and are better understood, the more it is sensed by the fresh students of the question that the whole Neanderthal question is in need of a revision.

If the given assumptions are true, then we are confronted by some strange major phenomena, viz., a long double line of human evolution, either in near-by or the same territories; a sudden extinction of one of the lines; and evolutionary sluggishness or pause in the other. The consideration of these hypotheses brings us into a maze of difficulties and contradictions. They lead to an outright polygeny—which is undemonstrable and improbable; or they concede the evolution of *H. sapiens* from the same old stock that gave also *H. neanderthalensis,* but deny the possibility of such evolution from Neanderthal man later on; they give us *H. sapiens,* without showing why, or how, and where he developed his superior make-up, and imply that, while he evidently developed much more rapidly at first to reach the status of *H. sapiens,* he then slackened greatly to remain, from the beginning of the post-glacial to this day, at nearly the same evolutional level.

They place *H. sapiens* in Africa or Asia, without troubling to offer the evidence of his ancient dominion in those regions. Or, if he lived in Europe, coexisting with the Neanderthaler, where are his remains, and why did he not prevail sooner over his inferior cousin? His traces, it will be recalled, never, in Europe or elsewhere, precede or coexist with, but always follow, the Mousterian. And where are there any other examples of a sudden, complete extinction of a whole large group of humanity; or of any wholesale Aurignacian conquest; or of any superior mentality of the *early* Aurignacians? And where are, in fact, in anything like a sufficient number, the undoubted skeletal remains of the early Aurignacians that could be used for comparison? Why did they, a new, superior species, strong and able enough to completely do away with the Neanderthaler, take over the poor Neanderthaler's caves and sites, and live in them exactly, except for technical differences in stone-chipping, as did their crude predecessors? And how shall we explain the anomalous fact of an invasion during the last ice encroachment, an unfavorable period, when man might logically be expected to move from, rather than into, such a territory?

Valid answers to these and other questions are as yet impossible. There is a need of much further exploration; of much further good fortune in locating additional skeletal remains of all periods, but particularly of the latest Mousterian and earliest Aurignacian; and of a new generation of able, critical workers, well equipped, and unhampered by tradition.

The *indications,* for the present, seem however to be the following:

(1) The Penck-Brückner conception of the Ice Age, as composed of four distinct periods of glaciation with three well-marked interglacial periods, is hard to harmonize with either the paleontological or the human evidence. Both of these tend to show rather but one main interglacial interval, from which there is a gradual progression towards an irregular cold period, after which follows an irregular postglacial. There is no marked faunal reaction that would correspond to the assumed third (Riss-Würm) full, warm interglacial. There is evident no substantial change, such as would necessarily be brought about by a marked alteration in climate, in man's housing and living habits from the middle Mousterian to the Magdalenian cultural periods.

(2) The Mousterian or Neanderthal phase of man begins apparently towards the end of the warm main interglacial. It is the period of the gradual cooling preceding the last main ice invasion, and the Neanderthal man reaches to, and probably somewhat beyond, the culmination of this invasion. If there had been two general ice periods separated by a substantial warm interglacial (the 3rd), then it would be necessary either to extend the existence of the Neanderthalers over the whole interglacial and much of the 3rd glacial—for which neither archeology nor paleontology affords any substantiation; or the Acheulian man, who followed the Chellean sometime after the middle of the main (Penck's 2nd) interglacial, would have to be extended over the whole 3rd glaciation and a large portion of the 3rd interglacial—which is impossible. There is plainly a great need here of adjustments of views between geology and prehistory.

(3) During his existence the Neanderthal man is brought face to face with great changes of environment. He is gradually confronted with harder winters, which demand more shelter, more clothing, more food, more fire, and storage of provisions; there are changes in the fauna which call for new adaptations and developments in hunting; and there are growing discomforts with, it may be assumed, increasing respiratory and other diseases, that call for new efforts and seriously hinder the growth of the population.

(4) Such a major change in the principal environmental factors must inevitably have brought about, on the one hand, greater mental as well as physical exertion, and on the other hand an intensification of natural selection, with the survival of only the more, and perishing of the less, fit. But greater sustained mental and physical exertion,

where not over the normal limits, leads inevitably towards greater efficiency attended by further bodily and mental development, which, with the simultaneous elimination of the weak and less fit, are the very essentials of progressive evolution. Strong evidence that a relatively rapid, progressive change, both mental and physical, was actually taking place during the Neanderthal period, is furnished by the great variability of the skeletal remains from this time.

(5) Such evolution with attendant mutations would certainly differ from region to region, as the sum of the factors affecting man differed, reaching a more advanced grade where the conditions in general proved the most favorable; while to many of the less favored groups disease, famine, and warfare would bring extinction. All these agencies are known to science today; only they acted with more freedom of old when social organization and mutual aid were at a low level.

(6) With these processes it is conceivable, if not inevitable, that, towards the height of the glacial invasion, the population decreased in numbers, and that the most fit or able-to-cope-with-the-conditions group or groups eventually alone survived, to carry on. Here seems to be a relatively simple, natural explanation of the progressive evolution of the Neanderthal man, and such evolution would inevitably carry his most advanced forms to those of primitive Aurignacian and *H. sapiens*—such *H. sapiens* as may to this day be seen in the Australian.

(7) The physical differences observable between Neanderthal and later man are essentially those of two categories, namely: (1) Reduction in musculature—that of the jaws as well as that of the body—with consequent changes in the teeth, jaws, face, and vault of the skull; and (2) Changes in the supraorbital torus, of the order known well to morphology as progressive infantilism. For both these categories of changes there are later parallelisms. Further reduction of teeth, jaws, and the facial bones has taken place since Magdalenian times, and is now going on in more highly civilized man of whatever racial derivation; while evolutionary "infantilism," or lesser development of some of the pronounced sex and age modifications, is commonly accepted as an explanation of the differences of the negrillo from the negro, and for the greater average reduction of the supraorbital ridges in the negro than in the whites. It would be illogical to deny the probable instrumentality of these agencies in men of an earlier period.

(8) Anthropology is thus confronted with the following conditions:

Neanderthal man is of a primitive physique, appears to have ended by a sudden and complete extinction, and to have been replaced by *H. sapiens.*

But there has been discovered no previous home of this *H. sapiens* outside of that of the Neanderthal man, nor any remains whatsoever of his ancestors; and, if he coexisted with Neanderthal man in the same territory, it is impossible to understand why he did not prevail sooner, or why he did not mix, or, above all, why he left no cultural and other remains of his existence in this region.

On the other hand, the Neanderthal man is now known to show wide morphological variation, leading in the direction of later man; and there are individuals among later men, even to this day, who show transitional features reminiscent of the Neanderthalers. This might be explained by an original common parentage of the two strains; or by an intermixture of the Neanderthal stock with the succeeding *H. sapiens;* or most naturally, it would seem, by a development, evolution, of the former into the latter.

(9) A critical examination of the known facts does not favor the assumption of a far-back common parentage and early Quaternary separation of *H. neanderthalensis* and *H. sapiens,* for lack of cultural evidence of *H. sapiens* and other great difficulties.

(10) A critical consideration of the question is equally unable to favor a separate origin of the two stocks with subsequent hybridization, for again there is no evidence of the pre-Aurignacian whereabouts and the doings of *H. sapiens,* there is no trace of his ancestry, and knowing his and his descendants' characteristics, it is impossible, as said already by Karl Pearson, to conceive his origin without a Neanderthal-like stage of development.

(11) There remains but the third alternative—which is the evolution of the Neanderthaler into later man. This proposition is not yet capable of fully conclusive demonstration. There is not yet enough material to definitely decide it. But the thoroughly sifted indications appear to the writer to favor this assumption.

(12) The great current need of prehistory, it may be accentuated once again, is more exploration and more good fortune in discoveries. Meanwhile there appears to be less justification for the conception of a Neanderthal *species* than there is for that of a Neanderthal *phase* of Man.

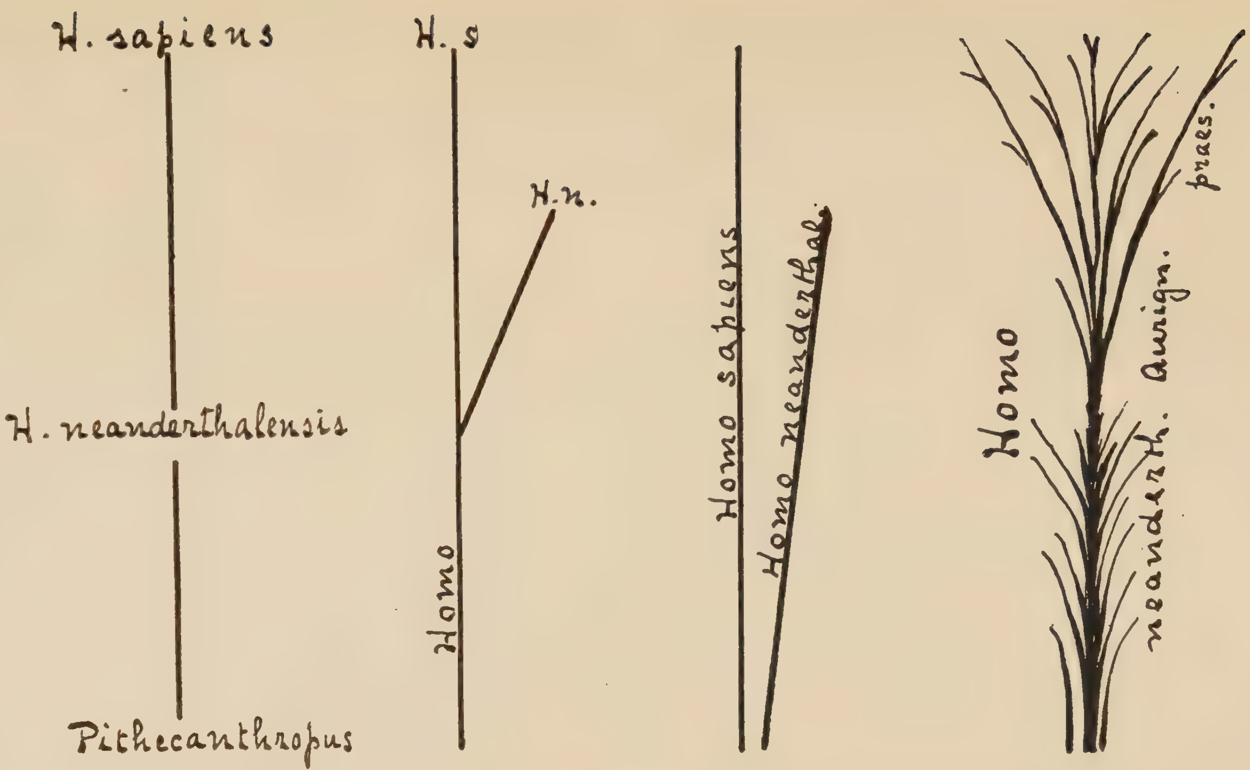

H. sapiens
H. neanderthalensis
Pithecanthropus
H. s
H. n.
Homo
Homo sapiens
Homo neanderthal.
Homo
neanderth.
Aurign.
praes.

FIG. 39.—Various conceptions as to the phylogenetic relation of the Neanderthal with earlier and later man; present evidence favors the view shown on the extreme right (Hrdlička).

THE TEETH OF EARLY MAN[1]

During the summer of 1923 and of 1927, the writer was able to revisit the various European Institutions in which the more valuable skeletal remains of early man and fossil European apes are preserved, and the occasions were utilized for careful reexamination and remeasurement of the teeth of these remains, more particularly of the lower molars, new data on which have become of great importance since the recent work on the Piltdown jaw.

Measurements of the teeth of most of the remains of early man and higher apes in Europe have been made and published before, some by the present writer. But they were made by almost as many different methods and instruments as individuals. Measurements of teeth are, it is well known, in themselves extraordinarily difficult, in addition to which there is no definite agreement as yet as to the exact points from which to measure, or the precise manner of measuring. As a result hardly any two separate measurements of the same teeth, even by the same observer, give absolutely the same values, and occasionally the differences are so marked that the student loses confidence in the records. Nor is he helped by the casts of the various specimens, for due to imperfections of technique and changes in plaster these generally give results on which one can place no great reliance.

Yet there is a growing evidence that accurate measurements of the teeth and particularly of the lower molars will be of signal value in the studies of human evolution and variation. The teeth have changed with time in their absolute as well as in their relative dimensions, and they are evidently still changing. There is therefore an urgent need of uniform data on all the important early material in this line, data that could safely be used by every worker as basis for comparison.

To obtain such data as far as possible has been the writer's aim for years; but the effort would have been quite useless without the formulation beforehand of a definite, uniform method of measurement, and such a method was developed, as has already been described in the American Journal of Physical Anthropology. The greatest former difficulty with measurements of teeth, particularly the molars, was that while some of the teeth were loose, others were still in position in the jaws. Now on a loose molar, particularly one from the lower jaw, it is relatively easy to secure the maximum length and breadth as well as other dimensions; but on the same tooth when in position and close contact with the neighboring teeth, accurate measurement of the maximum length is often difficult if not impossible. A few trials in this direction will soon convince the student of this fact. The difficulties are due to the frequently irregular contour of the teeth and to the greater or lesser bulging of the enamel below the upper border of the crown, which cannot be reached by the instrument when the teeth are in close apposition. If we add to this the fact that the maximum lengths of the three molars measured separately give, in many instances, a greater total length than that of the three teeth measured as a whole, the desirability of seeking the maximum length of the crown becomes questionable.

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[1] See Hrdlička, A., New Data on the Teeth of Early Man and Certain Fossil European Apes. Amer. Journ. Phys. Anthrop., Vol. 7, No. 1, 1924. The author desires also in this place to call attention to the very good work on fossil teeth of both man and apes carried on by William K. Gregory, Milo Hellman, and Gerrit S. Miller, Jr. (see bibliography).

The method arrived at by the writer was to measure the length of the molars along their median antero-posterior axis, in other words along the middle of the crown, from articulation (or contact) to articulation if the tooth is still in the jaw, or from the middle of the upper border of the articular facet anteriorly to a similar point of a similar facet posteriorly, if the teeth are loose. Even this method encounters some difficulties due to occasional notching of the anterior border of the tooth, or an absence or unusual position of the facets, but on the whole it has proved easier and more satisfactory than the measurement of length maximum. With the breadth there are no such difficulties. All observers, it seems, take the greatest breadth of the tooth, and the measurement may be safely defined as the greatest breadth of the crown at right angles to the length as well as to the vertical (mid-crown-mid-root) diameter of the tooth.

The principles of the method having been settled, the next point was that of instruments. It was soon seen that the ordinary *compas d'épaisseur,* though accurate enough for other purposes and though its blunt branches are very useful for the measurement of the maximum breadth of the teeth, was not entirely satisfactory for measuring the tooth length. The best instrument for the latter measurement was found to be a pair of sharp-pointed calipers, supplemented by a magnifying glass. The practice developed therefore of taking the length of the tooth by the sharp pointed compass under a magnifying glass, reading the measurement on a standard scale;[1] and of taking the maximum breadth of the tooth with the blunt extremities of a sliding compass, the latter well tested as to accuracy.

In the case of the third molar which lacks the posterior contact facet and in all other cases where the contact facet is missing or displaced, the length is measured to where the upper edge of the facet would normally be if it existed. In the case of teeth presenting peculiar conditions the worker must use his trained common sense.

Under these conditions results are obtained, particularly as to the length, that do not vary on repeated measurements more than, at most, two-tenths of a millimeter. With all due care, however, measurements on some teeth have to be repeated several times until the observer is fully satisfied as to the results. Such minutiae are quite necessary when dealing with the teeth of smaller primates or with teeth of such importance as those of fossil anthropoids and early man; and they are indispensable when studying the relations of the teeth in the two sexes, on the two sides, or among themselves in the same individual.

The human teeth that were measured or remeasured included the following:

The lower molars of the Piltdown Jaw—British Museum of Natural History;
The Mauer Jaw—Geologisch-Palaeontologisches Institut, Heidelberg;
Two jaws of Ehringsdorf—Städtisches Museum, Weimar;
Le Moustier youth—Museum für Kunstgewerbe, Berlin;
Spy skeletons—at the home of Professor Maximin Lohest, Liége;
Krapina remains—Narodni Muzej, Zagreb;
Aurignacian remains of Předmost—The Provincial Museum (of Natural History), Brno;
H. aurignacensis Hauseri—Museum für Kunstgewerbe, Berlin; and
The Chancelade skull—Museum of Perigueux, France.[2]

In addition to the preceding, various specimens were seen that on account of wear could not be measured, or that were too far from man and the upper apes to be of much use in this connection.

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[1] For which the rod of the sliding anthropometric compass is quite useful.

[2] The teeth of La Ferrassie and La Quina alone could not be measured. The former are still under study by Dr. Boule; the dimensions of the latter are given by Dr. Henri Martin in his L'Homme fossile de La Quina, Paris, 1922.

Size.—As shown in a previous communication on this subject,[1] the module $\frac{(\text{Length}+\text{Breadth})}{2}$ of the lower M 1 and M 2 (the M 3 being too irregular to measure) in present man ranges as follows:

	M1		M2	
	Male	Female	Male	Female
Whites	10.53	10.46	10.32	10.07
Negroes	11.03	10.69	10.77	10.57
Eskimo	11.13	10.99	10.95	10.63
Melanesians	11.24	11.15	10.84	10.41
Indians	11.28	10.78	10.93	10.30

Compared to the above the lower molars of early man give the values shown in the table on page 354.

The teeth of early man are seen from the table to be in general larger than the teeth of even the most macrodont groups of man of today. If it is born in mind that two of the groups of early teeth (Krapina, Předmost) comprise those of both males and females, the latter of which lower the averages, it may be said that with the exception of very few individual specimens all the teeth of early man are larger than those of any known group of man of today.

Although there is some correlation between the size of the teeth and the antiquity of the remains, this is not regular. The largest teeth are those of the Mousterian youth, followed in the order named by the Krapina man; the dawn-man of Piltdown; those of the Mauer jaw; some of the Předmost teeth;[2] those of Ehringsdorf; those of Spy No. 1; and those of *H. aurignacensis* (Berlin); while the smallest are those of Spy No. 2 and some of the Předmost molars. The largest individual teeth found were the left M1 of Krapina jaws C (13.1 x 12.1 mm.) and D (13.0 x 12.0); the right M2 of the jaw of Mauer (12.8 x 12.0); and the right M3 of Le Moustier (13.0 x 12.0); as well as a loose Krapina tooth (13.0 x 12.0). Notwithstanding these irregularities in individuals and forms of early man the indications given by the above facts are that they are all derived from decidedly macrodont predecessors; that man's precursors were in all probability also highly macrodont; and that a gradual reduction in tooth size has taken place during man's progress, becoming now most marked in the more civilized parts of the white race.

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[1] Amer. Journ. Phys. Anthrop., Vol. 6, No. 4, pp. 423-438, 1923.

[2] Middle to upper Aurignacian.

SIZE OF LOWER MOLARS IN EARLY MAN

	M1			M2			M3		
	Length (mean of r. and l.)	Breadth (mean of r. and l.)	Crown Module	Length (mean of r. and l.)	Breadth (mean of r. and l.)	Crown Module	Length (mean of r. and l.)	Breadth (mean of r. and l.)	Crown Module
Piltdown	12.0	11.0	*11.50*	12.30	11.20	*11.75*	.....	.....	.....
Mauer	11.20	11.20	*11.20*	11.75	11.0	*11.37*	r. 11.75	11.0	*11.38*
Ehringsdorf adult	11.45	11.0	*11.23*	12.10	10.65	*11.37*	11.70	9.5	*10.60*
Ehringsdorf child	11.90	10.50	*11.20*	12.50	10.80	*11.65*	.....	.....	.....
Le Moustier	12.10	11.35	*11.73*	12.75	11.30	*12.02*	12.90	11.70	*12.30*
Spy No. 2	11.35	11.75	*11.55*	11.35	11.5	*11.43*	11.80	11.75	*11.77*
Spy No. 1	11.0	11.0	*11.0*	11.0	11.0	*11.0*	10.6	10.8	*10.7*
Krapina (both sexes) (mean of 12 teeth)	12.04	11.33	*11.68*	12.07[1]	11.04	*11.56*	12.01[1]	10.96	*11.48*
Předmost (both sexes; 18 teeth)	11.81	10.72	*11.26*	11.18[2]	10.70	*10.94*	11.66[3]	10.86	*11.26*
H. aurignac. (Berlin)	11.70	11.40	*11.55*	11.40	11.35	*11.38*	10.10	10.60	*10.35*

[1] Seven teeth. [2] Twelve teeth. [3] Five teeth.

Relative proportions.—The relative proportions of the lower molars are readily expressed by the Crown Index $\frac{\text{Crown breadth} \times 100.}{\text{Crown length}}$ This index, as we proceed back in time, decreases gradually in man, and from man to the lower primates. The remeasurement of the teeth of early man gave values and indices which are reported in detail on pages 356-360.

The principal points brought out by the data are briefly as follows:

1. As in absolute, so in relative size, the lower molars bear a general definite correlation with time; the greater their antiquity the greater the relative length of the teeth and *vice versa.*

2. The breadth (or stoutness) of the tooth in the course of man's existence has shown but little change, much less than the length.

3. The facts indicate that in man's precursors the lower molars were longer but probably only slightly stouter than they are in man of today.

4. Concerning the lower molars in present man, it is safe to regard as primitive or phylogenetically inferior a tooth that is absolutely large, or one that is relatively long, giving a low crown index.

The progressive shortening of the human lower molars must have been concomitant, it is plain, with a progressive shortening of the jaws, though the change was primarily in the teeth and not in the jaws; had it been in the latter there would in all likelihood be observable a compensatory increase in the breadth (stoutness) of the teeth and the M3 would be least affected, which is not the case.

Some additional observations of interest were possible on the M3 in the remains of early man. With very few exceptions this tooth shows no degeneracy or alteration such as are common in modern man. As may be seen in the table on the "Size of the lower molars in early man" (p. 354) there is a progression in the size of the teeth from before backward in the jaw of Piltdown, though in this case we have only the more anterior two molars; in the jaw of Mauer, where the M2 is larger than M1 and M3 larger than M2; in both the jaws of Ehringsdorf, where M2 is larger than M1, though in the adult the M3 is smaller than either of the preceding teeth; and in the Mousterian youth, where we have a decided progression in the size of the three molars from before backward. In all the rest of the teeth, the M2 averages slightly less than the M1, and the M3 is smaller than the M2, except in the Předmost teeth where the M3 is larger than the M2, equalling the M1. Individually, a progression from before backwards in the size of the three molars was

DIMENSIONS OF TEETH OF EARLY MAN: LOWER MOLARS

	M1			M2			M3			M1, 2, 3	
	L[1]	B[2]	I[3]	L	B	I	L	B	I	L	I[4]
The Piltdown Jaw........r.	12.0	11.0	*91.7*	12.3	11.2	*91.1*	....	....	....	....	....
l.	12.0	11.0	*91.7*	....	....	....	....	....	....	....	*31.0*
The Mauer Jaw..........r.	11.2	11.2	*100.0*	12.8	12.0	*93.7*	12.0	11.0	*91.7*	36.0	*33.3*
l.	....	....	....	....	....	....	11.5	11.0	*95.7*	....	....
Ehringsdorf Adult.......r.	11.2	11.0	*98.2*	12.2	10.8	*88.5*	11.7	9.5	*81.2*	....	....
l.	11.7	11.0	*94.0*	12.0	11.5	*95.8*	(8.0	7.7)	*(96.2)*	....	....
Child..................r.	....	....	....	....	....	....	....	....	....	....	....
l.	11.9	10.5	*88.2*	12.5	10.8	*86.4*	....	....	....	....	....
Le Moustier.............r.	12.2	11.5	*94.3*	12.5	11.3	*90.4*	13.0	12.0^5	*92.3*	....	....
l.	12.0	11.2	*93.3*	13.0	11.3	*86.9*	12.8^5	11.4	*89.1*	....	....
Spy No. 2...............r.	11.2	11.7	*104.7*	11.2	11.3	*100.9*	11.4	11.7	*102.6*	....	....
l.	11.5	11.8	*102.6*	11.5	11.7	*101.7*	12.2	11.8	*96.7*	....	....
No. 1..................r.	11.0	11.0	*100.0*	11.0	11.0	*100.0*	10.2	11.0	*107.8*	....	....
l.	11.0	11.0	*100.0*	11.0	11.0	*100.0*	11.0	10.6	*96.4*	....	....
Krapina Jaws B........r.	....	....	....	....	....	....	....	....	....	....	....
(child)................l.	11.1	10.2	*91.9*	....	....	....	....	....	....	....	....
C........r.	12.9	12.1	*93.8*	....	....	....	....	....	....	....	....
(child)................l.	13.1	12.1	*92.4*	....	....	....	....	....	....	....	....
D........r.	....	....	....	....	....	....	....	....	....	....	....
(adult or near)........l.	11.7	10.6	*90.6*	....	....	....	....	....	....	....	....
E........r.	....	....	....	....	....	....	....	....	....	....	....
l.	13.0	12.0	*92.3*	12.7	11.4	*89.8*	....	....	....	....	....
G........r.	12.0	11.2	*93.3*	12.9	11.2	*86.8*	11.5	11.0	*95.6*	36.1	*31.0*
l.	...	...	...	...	...	...	...	...	...	...	...

DIMENSIONS OF TEETH OF EARLY MAN: LOWER MOLARS—CONTINUED

	M1			M2			M3			M1, 2, 3	
	L[1]	B[2]	I[3]	L	B	I	L	B	I	L	I[4]
Krapina jaws H........r.	12.0	11.0	*91.7*	12.0	11.2	*93.3*	12.0	11.0	*91.7*	36.0	*31.1*
l.	11.9	10.9	*91.6*	11.9	11.1	*93.3*	12.0	10.8	*90.0*	35.6	*31.2*
I........r.	11.7	11.8[5]	*100.8*[5]	11.8	....	....	11.8	....	....	35.0	?
l.	11.3	11.2	*99.1*	12.2	11.4	*93.4*	....	....	....	....	....
Separate Teeth[6].........r.	12.3	12.0	*97.6*	....	....	....	....	....	....	....	....
r.	....	....	....	11.0	11.0	*100.0*	....	....	....	....	....
r.	....	....	....	....	....	....	12.0	11.0	*91.7*	....	....
r.	....	....	....	....	....	....	12.5	11.0	*88.0*	....	....
r.	....	....	....	....	....	....	13.0	12.0	*92.3*	....	....
r.	....	....	....	....	....	....	11.1	9.9	*89.2*	....	....
l.	11.5	10.8	*93.9*	....	....	....	....	....	....	....	....
H. aurignacensis (Předmost)[7]											
Jaws..................r.	11.8	10.1	*85.6*	11.0	10.0	*90.9*	....	....	....	....	....
I.........l.	11.4	10.2	*89.5*	10.1	9.9	*98.0*	....	....	....	....	....
Juv. II........r.	12.2	10.9	*89.3*	....	....	....	....	....	....	....	....
l.	12.2	10.9	*89.3*	....	....	....	....	....	....	....	....
III........r.	11.8	11.0	*93.2*	12.0	11.2	*93.3*	12.7	11.4	*89.8*	36.0	*31.7*
l.	11.9	11.3	*95.0*	12.6	11.7	*92.9*	....	....	....	....	....
V........r.	12.0	10.7	*89.2*	10.8	10.6	*98.1*	....	....	....	....	....
l.	11.7	10.7	*91.4*	10.9	10.6	*97.2*	....	....	....	....	....
Juv. VI........r.	....	....	....	....	....	....	....	....	....	....	....
l.	12.9	11.0	*85.3*	....	....	....	....	....	....	....	....

DIMENSIONS OF TEETH OF EARLY MAN: LOWER MOLARS—CONTINUED

	M1			M2			M3			M1, 2, 3	
H. aurignacensis (Předmost)[7]	L[1]	B[2]	I[3]	L	B	I	L	B	I	L	I[4]
Jaws IX........r.	12.6	11.3	*89.7*	12.2	11.7	*95.9*	12.5	11.7[5]	*93.6*	....	....
l.	12.5	11.0	*88.0*	12.1	11.3	*93.4*	13.0	11.2	*86.2*	36.6	*30.9*
X........r.	10.6	9.8	*92.4*	10.0	9.8	*98.0*	10.0	10.0	*100.0*	31.3	*31.9*
l.	10.8	....	....	10.5	....	....	10.5	....	....	31.7	....
XIV........r.	12.2	11.2	*91.8*	....	....	....	....	....	....	....	....
l.	11.4	10.9	*95.6*	12.0	11.6	*96.7*	....	....	....	....	....
3070........r.	10.3	10.0	*97.1*	9.5	10.0	*105.3*	10.1	10.0	*99.0*	29.4	*34.0*
l.	....	....	....	....	....	....	....	....	....	....	....
476........r.	11.5	10.5	*91.3*	....	....	....	....	....	....	....	....
l.	11.0	10.4	*94.6*	11.0[5]	10.0	*90.9*	....	....	....	....	....
Juv. 259........r.	11.8	11.0	*93.2*	....	....	....	....	....	....	....	....
l.	...	...	...	...	...	...	...	...	...	...	...
H. aurignacensis (in Berlin)............r.	11.7	11.2	*95.7*	11.3	11.2	*99.1*	9.0	10.2	*113.3*	32.3	*34.7*
l.	11.7	11.6	*99.1*	11.5	11.5	*100.0*	11.2	11.0	*98.2*	32.5	*35.7*

[1] At middle, from middle of upper border of anterior to same point (or corresponding one) of contact facet. [2] Max. [3] $\frac{\text{B} \times 100}{\text{L}}$ [4] $\frac{\text{B. max.} \times 100}{\text{L. of M 1, 2 and 3}}$ [5] Near. [6] Identification not always absolutely certain. [7] Middle to upper Aurignacian.

MOLAR INDICES $\frac{\text{Breadth Max.} \times 100}{\text{Median Length}}$ ARRANGED CONSECUTIVELY

Locality	M1 L. B. Index	Locality	M2 L. B. Index	Locality	M3 L. B. Index	Locality	All 3 Index
Předmost VI	85.3	Ehringsdorf, child	86.4	Ehringsdorf, r. ad.	81.2	Předmost, IX, l.	30.9
“ I r.	85.6	Krapina G	86.8	Předmost, IX, l.	86.2	Piltdown, r. near	31.0
“ IX l.	88.0	Le Moustier, l.	86.9	Krapina, sep. t.	88.0	Krapina, G.	31.0
Ehringsdorf, child	88.2	Ehringsdorf, ad. r.	88.5	Le Moustier, l.	89.1	“ H, r.	31.1
Předmost, V, r.	89.2	Krapina, E.	89.8	Krapina, sep. t.	89.2	“ H, l.	31.2
“ II, r., l.	89.3	Le Moustier, r.	90.4	Předmost, III, r.	89.8	Předmost, III, r.	31.7
“ I, l.	89.5	Předmost, I, r.	90.9	Krapina, H, l.	90.0	Krapina, X, r.	31.9
“ IX, r.	89.7	Předmost No. 476	90.9	“ H, r.	91.7	Mauer, r.	33.3
Krapina, D.	90.6	Piltdown	91.1	Mauer, r.	91.7	Předmost No. 3070	34.0
Předmost No. 476	91.3	Předmost, III, l.	92.9	Krapina, sep. t.	91.7	*H. aurignac.* (Berlin) r.	34.7
“ V, l.	91.4	“ III, r.	93.3	Le Moustier, r.	92.3	*H. aurignac.* (Berlin) l.	35.7
Krapina, H, l.	91.6	Krapina, H, r., l.	93.3	Krapina, sep. t.	92.3		
Piltdown, r., l.	91.7	“ I	93.4	Předmost, IX, r.	93.6		
Krapina H, r.	91.7	Předmost, IX, l.	93.4	Krapina, G	95.6		
Předmost, XIV, r.	91.8	Mauer	93.7	Mauer, l.	95.7		
Krapina B	91.9	Ehringsdorf, ad. l.	95.8	Spy 1, l.	96.4		
“ E	92.3	Předmost, IX, r.	95.9	“ 2, l.	96.7		
“ C, l.	92.4	“ XIV	96.7	*H. aurignac.* (Berlin), l.	98.2		
Předmost, X	92.4	“ I, r.	97.1	Předmost, 3070	99.0		
“ 259	93.2	“ V, l.	97.2	“ X	100.0		
“ III, r.	93.2	“ X, r.	98.0	Spy, 2, r.	102.6		
Le Moustier, l.	93.3	“ V, r.	98.1	“ 1, r.	107.8		

MOLAR INDICES $\frac{\text{Breadth Max.} \times 100}{\text{Median Length}}$ ARRANGED CONSECUTIVELY—CONTINUED

Locality	M1 L. B. Index	Locality	M2 L. B. Index	Locality	M3 L. B. Index	Locality	All 3 Index
Krapina, G.	93.3	*H. aurignac.* (Berlin), r.	99.1	*H. aurignac.*, r.	113.3		
" C, r.	93.8	" " l.	100.0				
" tooth	93.9	Krapina, sep. t.	100.0				
Ehringsdorf ad. r.	94.0	Spy, 1, r., l.	100.0				
Le Moustier, r.	94.3	" 2, r.	100.9				
Předmost No. 476	94.6	" 2, l.	101.7				
" III, l.	95.0	Předmost, No. 3070	105.3				
" XIV	95.6						
H. aurignac. (Berlin), r.	95.7						
Předmost, 3070	97.1						
Krapina, sep. t.	97.6						
Ehringsdorf, ad. r.	98.2						
Krapina, I, l.	99.1						
H. aurignac. (Berlin), l.	99.1						
Mauer	100.0						
Spy, 1, r., l.	100.0						
Krapina, I, r.	100.8						
Spy, 2, l.	102.6						
" 2, r.	104.7						

observed in the Předmost jaw No. 3, while in jaw No. 9 from the same locality the progression on the right is M1, M2, M3 (the M3 being the largest), while on the left it is M2, M1, M3. We see thus that in early man, the ancient condition of the molars progressing in size from before backwards is still more or less in evidence in the older forms, disappearing more and more as recent times are approached.

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Concluding Remarks

This work has been limited to the more ancient skeletal remains of man, or to those up to the end of the Mousterian cultural period, which ended during the last ice invasion. A good number of defective specimens, of isolated teeth and bones, and of remains imperfectly known, such as Podkoumok skull or the Crimea neanderthaloid bones, have been omitted; they would add but little to the presentation. There are in addition, however, many valuable remains of similar nature from later paleolithic times, the Aurignacian, Solutrean, and Magdalenian; these, though nearly all known to the writer personally, and though presenting many points of much interest, must be left for a future revision. They will call for a large volume by themselves, and that a critical volume, for the reports that have accumulated on these remains lack much in uniformity and are much marred by speculation and by errors due to the earlier lack of comparable material. It may safely be foretold that the notions as to *Homo sapiens,* the idolatry of the Cro-Magnons, the ideas of direct Eskimo connections, the conclusions about negroids in Europe, and other vested opinions will suffer much elucidation.

The most notable individual skeletal remains of the post-Mousterian paleolithic times are those of Předmost, upper Aurignacian, comprising 14 skeletons some of which are almost complete, with parts of 6 others, found by K. Maška and preserved in Zemské Museum, Brno, Moravia; the apparently Aurignacian skeletons of the French and Italian Riviera (Mentone, Grimaldi); and the Aurignacian to Magdalenian skulls and skeletons of Most (Brüx), Brno (Brünn), Canstadt, Chancelade, Combe-Capelle, Cro-Magnon, Eguisheim, Lauč, Laugerie Haute and L. Basse, Obercassel, Paviland, Solutrée, Viestonice, etc., together with some of those of Spain (Alfolea) and North Africa (Djebel Fartas, etc.). The literature on these remains is extensive and widely scattered. Some of the originals are known to but a few men, have never been studied thoroughly, and are difficult of access; others have received much attention. The most valuable of the series, that of Předmost, is still in the process of preparation for publication.

The striking thing about these remains is the great dearth of specimens that could be definitely assigned to the early Aurignacian. Yet it is precisely this material which is most needed.

The later remains show many a primitive feature of evidently transitional character between earlier man and the modern. These occurrences indicate still more primitive and transitional conditions in the further past; and this further past falls essentially to the earliest Aurignacian, from which there is as yet the greatest dearth of skeletal human material. Between the late Mousterian and the early Aurignacian there has taken place apparently, through the intensified cold or through an epidemic or by both, a crisis which reduced the population so much that the linkage between the preceding and later time has been much weakened. This transition period needs clearing more than almost any other in prehistory; and this clearing may come perhaps from marginal regions, outside of Europe or at least western Europe.

Besides the above described or enumerated well authenticated specimens, there are scattered in the museums of Europe many others, for which greater or less antiquity has at some time been, or is still being, claimed. In many of these instances the student finds that the evidence adduced is insufficient and that the testimony of the skeletal parts themselves speaks rather against any great age, or leaves the subject in serious doubt. It would seem best for the progress of science to eliminate all such specimens from consideration until new and ample evidence is found to convince us that they really deserve a place among the precious authentic documents that represent the earlier phases of man's natural history.

The ever accumulating finds that throw light on the physical past of man naturally stimulate further exploration in these lines; and the various failures and uncertainties connected with some of the finds in the past have impressed all investigators in the field with the necessity of the most careful and properly controlled procedure. Besides men of science, the educated public, engineers controlling public works, and even many among the workmen in Europe, have been impressed by these remarkable discoveries, and in hundreds of instances are doubtless watching for new treasures. Under these conditions we are justified in hoping that from time to time there shall come to light further important additions to the precious material already in our hands; and that these additions will fill the existing gaps, and gradually extend farther and farther back, to the earliest forms of man and even to the intermediary forms between man and his ancestral stock, and perhaps eventually even to the source of these link-forms themselves, to the peculiar, morphologically unstable family of the anthropogenous primates that represented the human phylum before the arising of human precursors.

While the anthropologist is thus painstakingly and slowly reconstructing the past physical history of man, he is also with every new fact adding another imperishable smaller or larger block to the solid foundation upon which will stand not only man's future knowledge in regard to himself, but also the understanding of the laws of his further development. It is upon this foundation that will rise sound and beneficent rules of future human behavior, and of true scientific human eugenics. This is a part of the service of anthropology to humanity.

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ADDENDUM

Since the preceding was put in type, new finds of importance have been made in northern China. Not much definite is known as yet about these discoveries; what has been reported is briefly as follows.

THE SINANTHROPUS

The name of *Sinanthropus pekinensis* was given in 1927 by Davidson Black, Professor of Anatomy at the Peking Union Medical College, to some ancient human remains that had been found during the period 1920 to 1927 in evidently Pleistocene deposits at Chou Kou Tien, 25 miles from Peking. The amount of material already discovered is relatively large. It consists of a portion of an adult skull and the symphyseal part of a child's lower jaw; many teeth; parts of the calvarium of a juvenile individual; and a nearly complete adult calvarium. Recent cable advices have claimed also nine headless skeletons, but of these there is no confirmation. The human remains have thus far been found in five separate loci; for the most part the remains are embedded in hard travertine; and they are associated with mammalian fossil fauna that is believed to be lower Quaternary.

Professor Black has given a description of three of the teeth and of the fragments of the two mandibles. The adult jaw resembles much the "g" Krapina (Hrdlička), but is somewhat smaller, less heavy, and the M3 shows a distinct diminution in size as compared to the first and second, which are about equal. The latest cable reports on the skull (December 29, 1929) are that it is of a very interesting character. Before the discovery of the adult skull, Sir Arthur Keith, and shortly after that Professor Elliot Smith, published each an account of the finds, with some rather premature though interesting speculations as to its significance. Little definite is known as yet about the site, but a report upon it by Teilhard de Chardin is in preparation.

A letter to the writer from Professor Black, dated December 13, 1929 (received January 16, 1930), reads as follows:

> This is just a hasty chit to let you know that on December 2 Mr. W. C. Pei, who has been in charge of the field-work this year, discovered an uncrushed and almost complete adult Sinanthropus skull in the Chou Kou Tien deposit. The news will be specially announced at a meeting of the Geological Society of China on December 28, but I am sending this off beforehand.

I am not yet sure myself how much of the skull is preserved since I have so far only uncovered the vault from the lambda to the massive supraorbital region and from one temporal squame to the other. I have taken casts of it in this condition and will recover the vault in plaster before uncovering the base in order to take no chances of breakage. The left half of the skull below the temporal squame is embedded in very hard travertine and the nasal and part of the glabellar region is similarly enclosed so it will be some time before the whole is entirely worked out. But the base which is still in its field wrappings of burlap and plaster is, I think, fairly free from travertine, and can easily be exposed after I have completed the preliminary casts of the vault. I do not yet know if one or both poria are preserved but I am hopeful from the look of the vault. The supraorbital ridges are massive as one expected from the jaw. They are apparently equal in development to those of Pithecanthropus. The frontal and parietal development of Sinanthropus is much more advanced than the Java type but the frontal development is apparently less than in Eoanthropus. Sinanthropus is of approximately similar length to Pithecanthropus but its shape implies a considerably larger volume than the latter. I shall report on this specimen at the Annual Meeting of the Geographical Society in February when I will know a bit more about it. The December 28 Meeting is only to announce the discovery and to show the casts and photos. I hope to have a fairly complete report on the cranium with photos and drawings ready before the spring and I shall send you further details as soon as I know anything. We have not nearly completed the working of the original deposit and this is the fifth distinct locus within it that has yielded Sinanthropus remains. I now have enough teeth alone to describe completely the deciduous and permanent dentition of this form aside from the two jaws and innumerable other specimens still in their field wrappings. We need the leg, arm and foot bones now to complete the picture but if our luck holds as it has so far we should get these next year.

I shall let you know when my work has progressed further exactly how much of this specimen is preserved.

On January 27, the preceding was supplemented by a more explicit statement, and with it Professor Black had the great kindness to enclose a precious photograph. The statement reads as follows:

DISCOVERY OF SKULL OF ADULT SINANTHROPUS AT CHOU KOU TIEN

On December 2 last Mr. W. C. Pei of the staff of the Cenozoic Laboratory of the Geological Survey of China, while excavating a sheltered recess of the main deposit at Chou Kou Tien discovered the greater part of an uncrushed adult skull of *Sinanthropus pekinensis.* Mr. Pei at once recognized the importance of the specimen and personally carried out the difficult work of excavation and subsequent field preparation of the block of matrix in which it lay. It is entirely due to his skill and devotion that this bulky mass with its unique and fragile contents reached the Cenozoic Laboratory quite undamaged.

Mr. Pei has been in charge of the Geological Survey's field excavations at Chou Kou Tien during the past season. He was also associated with Drs. Bohlin and C. C. Young in the work of excavation carried on at that site during the season of 1928 which resulted in the recovery of the major parts of two lower jaws and numerous teeth and skull fragments referable to the genus *Sinanthropus.* Within the main cave deposit at Chou Kou Tien up to the present time *Sinanthropus* remains have been recovered from five different loci, three of which, including the last major find, have been discovered by Mr. Pei during the last season's work. Contrary to any reports which have been circulated, no skeletal parts other than the skull and numerous isolated teeth have been recovered during this year's excavations.

It should be noted that the different *Sinanthropus* loci discovered within the main Chou Kou Tien deposit are all clearly contemporaneous with one another, being Lower Quarternary (Polycene) in age. This latter statement is based on the evidence collected in a preliminary report on the geology and paleontology of the site by Père Teilhard de Chardin and Dr. C. C. Young which is now in press. Further it should be added that up to the present time, though hundreds of cubic meters of material have been examined, no artifacts of any nature have been encountered nor has any trace of the usage of fire been observed.

The greater part of the left lateral surface and the fore part of the base of this unique skull specimen of *Sinanthropus* is still embedded in a block of very hard travertine. The vault of the skull from its massive brow ridges to the occiput, and the whole right side of the specimen was however supported within a relatively soft matrix which has now been removed. In the present stage of its preparation it thus becomes apparent that the brain case has been almost completely preserved while most of the facial region would seem to be lacking.

The skull of *Sinanthropus* would seem to be of approximately similar length to that of *Pithecanthropus* and like the latter form is provided with massive brow ridges, a feature to be correlated with a powerful jaw mechanism. However, *Sinanthropus* characteristically differs from the Java type in the following important features: relatively well developed frontal eminences, well localized parietal eminences and greater height of skull vault, all these characters pointing to a relatively greater brain capacity in *Sinanthropus.* The mastoid processes of *Sinanthropus* are small and massive. The sockets in which the lower jaw articulated are well preserved on both sides, a circumstance which will be of great value in the restoration of the lower jaw fragments recovered in 1928.

In general it may be said that while the new skull specimen bears out what little was already known from other fragments, the perfection of its preservation will enable much to be learned that is now obscure concerning the evolution of the head region in early man. Preliminary photographs and notes will be published in an early issue of the Bulletin of the Geological Society of China and a more complete report on the specimen will be made at the annual meeting of the Society to be held next February.

Davidson Black,
Honorary Director, Cenozoic Research Laboratory,
Geological Survey of China.

COMMENTS

It is now certain that the Peking discoveries are of decided importance. They show us the presence of early man much farther east than he has previously been known or legitimately suspected. The exact chronological and anthropological position of the finds remains to be determined. As to age, the inclination was at first to place the remains in the Tertiary. They are now regarded as earlier Quaternary. Possibly even this may be subject to revision.

Professor Black's illustration of the adult jaw, and above all the very clear and satisfactory full-size photographs of the skull, make possible the formation of some fairly definite morphological opinions. The lower jaw resembles very closely No. "g" of Krapina, and the plainly diminished third molar suggests a moderate rather than extreme antiquity. The skull is clearly neanderthaloid. It appears to represent no distinct genus, species, or even a pronounced variety. And it is not like the lowest type of the Neanderthaler, but corresponds rather to the better developed specimens of that class, such as the Galilee skull. How far these still necessarily provisional views may be substantiated, remains to be seen. Even a later Neanderthaler in China would, however, be a discovery of much interest as well as importance.

Grateful acknowledgments are hereby given to Professor Black for his most generous attitude in this matter and for his exceedingly valuable assistance.

Note.—While this is about to be issued, Professor Black most kindly sends to the writer a series of very valuable photographs of the specimen as finally disengaged. The two main views are here reproduced. They greatly strengthen the impression of the specimens as expressed above. Had the skull been found in Europe or in Asia Minor, it could hardly be taken by any expert student of the subject as anything else than Neanderthaler.

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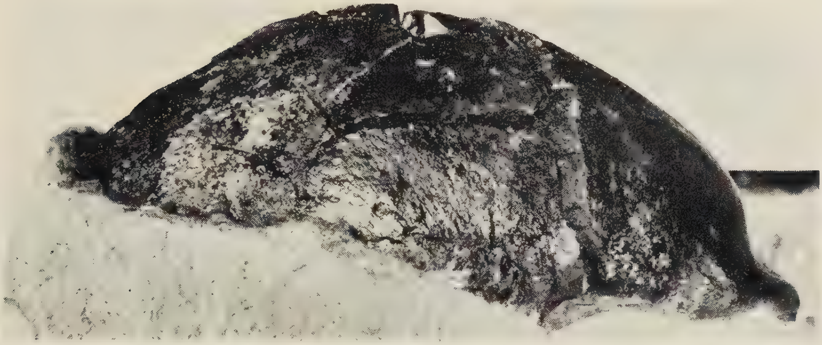

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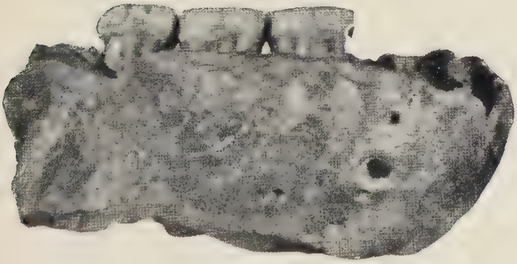

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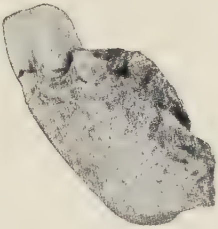
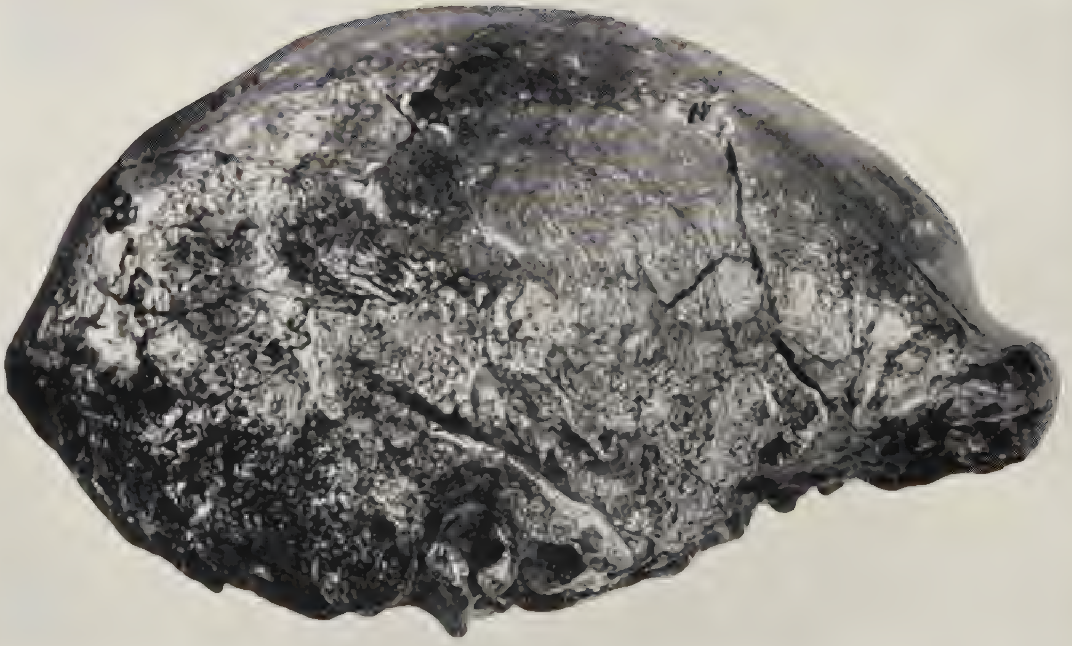
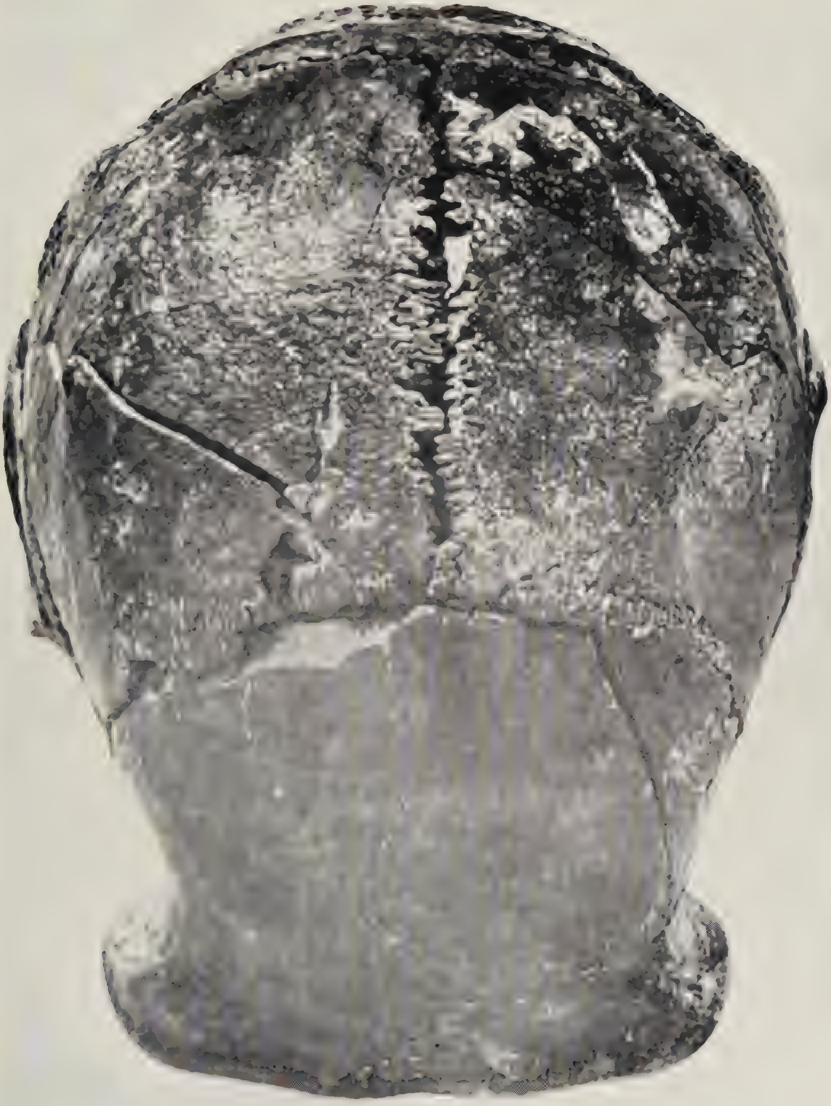


3

1. Skull of adult (?) *Sinanthropus,* side (?) view.
2. Mesial view of the six normae of the adult *Sinanthropus* jaw fragment, mesial view. (After Black.)
3. The unerupted left permanent canine of *Sinanthropus* juv. on the fractured surface. (After Black.)



Sinanthropus. Photograph from Prof. Davidson Black.



Sinanthropus. Photograph from Prof. Davidson Black.

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